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# INSTITUTE OF GAS TECHNOLOGY

THE GAS INDUSTRY'S OWN EDUCATIONAL AND RESEARCH FACILITY

CHICAGO 16, ILLINOIS

# GAS ABSTRACTS

JULY, 1960

VOLUME 16 NUMBER 7

AFFILIATED WITH

ILLINOIS INSTITUTE OF TECHNOLOGY

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GAS ABSTRACTS is published and distributed monthly by the Institute of Gas Technology, Chicago 16, Illinois. The contents of selected papers and patents are reviewed impartially by the editorial staff and material of potential interest to the Gas Industry is presented.

Subscription rates to nonmembers of the Institute: $18.00 per year to U. S. addresses; $22.00 foreign. Regardless of the month in which it is entered, each subscription starts with the January issue. A gold-stamped fabrikoid binder for the year, and title- and end-pages for that volume, are sent with the January issue. A complete index to the year's issues is mailed as soon after the year's end as it can be prepared, edited and printed.


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A microfilm edition of Gas Abstracts can be supplied by University Microfilms, 313 N. First St., Ann Arbor, Michigan.

## 1. MANAGEMENT

### Gas Industry Expansion

**Investment in Fuel and Power Industries.** M. F. Foss and W. Leibowitz. *Survey of Current Business 40,* 18 (1960) June (7 pp.)

While 1960 finds the current and near-term anticipated investment of electric and gas utilities not far from earlier peaks, petroleum investment is well below, and at present shows no signs of achieving previous highs in the near future. In the past few years the productive capacity of the petroleum industry has been running in excess of demand, with a resultant lowering of new domestic capital expenditures. This article covers the conventional energy sources and the associated private investment; atomic power and chemical rocket fuels are not included.

**Natural Gas, A New Component in the Municipal Power Distribution.** G. Hogenauer. *Gas- u Wasserfach 101,* 514 (1960) May 27 (8 pp. German text)

Continuous increase of natural gas supplies from Bavaria and the initiative of the Public Utility Corp. of Munich have made natural gas an important factor in the regional gas supply. The portion of natural gas in Bavaria's total gas production has reached 30%, whereby the coke situation is considerably alleviated. The significance which natural gas will acquire in other parts of the country in the future gives particular impact to the author's statement with respect to the geology of the deposits, soil conditions, and his detailed remarks about the fabrication, laying, operation and expense of the feeder line, and town gas production based on natural gas as well as the advantages and disadvantages of the direct use of natural gas.

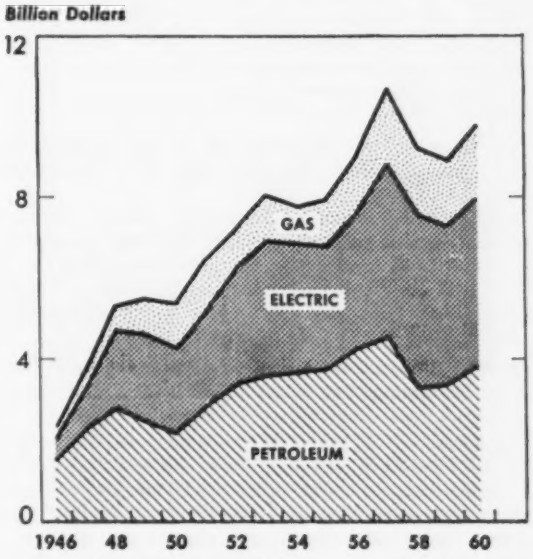
**Weighty Decisions Must Be Taken in the Next Few Years.** D. D. Melvin. *Gas World 151,* 908 (1960) June 4 (7 pp.); **Energy Trends and Training for the Future.** *Gas Times 94,* 33 (1960) June (3 pp.); **The President's Address.** D. D. Melvin. *Gas J. 302,* 372 (1960) June 8 (7 pp.)

After a brief review of the outstanding developments in the gas industry in the past 60 years, the author turns to the future. While traditional techniques of operation will continue for a long time, new methods of gas making, involving other branches of chemical engineering, novel methods of distribution and storage, and extended applications in the domestic, commercial and industrial fields, will call for people whose training is such that transfers between functions are possible.

**What You Can Expect in 1960-61 Pipeline Construction Costs.** G. Kinney. *Oil Gas J. 58,* 110 (1960) June 27 (5 pp.)

Various estimates show the variety of approaches by different companies. They should not be considered as actual costs, but only as anticipated costs of specific projects in specific locations. Examples selected show a wide range of diameters and varied terrain to represent as many construction situations as possible.

**Annual Capital Investment of Energy Industries**




(From *Investment in Fuel . . .* see Abstract at left.)

### Gas Industry Management

**Application of Exploration and Production Cost Trends to Determination of Fair-Market Gas Prices.** W. S. Eggleston. *J. Petrol. Tech. 12,* 11 (1960) June (4 pp.)

Method of determining fair-market prices for gas sold in interstate commerce is outlined. Average weighted increase in the costs of exploration and production over the past 10 years amounts to approximately 108%. Application of this increase to prices established in 1948 can be used to determine prices for current years as a point of departure for the purpose of establishing specific prices. Method indicates a price of 17.7 cents/MCF in 1957, 19 cents/MCF in 1958 and approximately 21 cents/MCF in 1959 for South Louisiana. Specific prices for this area could be determined by such modifying factors as reserves, deliverability, location, quality and pressure of the gas.

**Live Gas.** S. Everard. I.G.E. Communication No. 573; *Gas Times 94,* 47 (1960) June (3 pp.); *Gas World 151,* 932 (1960) June 4 (4pp.); **Discussion.** *Gas World 151,* 1071 (1960) June 25 (5 pp.)

Relationship between the consumer and the Gas Board (England) are discussed and the purpose of market research in interpreting the consumer's wants are outlined. Factors that have contributed to the steady fall in average domestic gas consumption for the past decade are analyzed. Effects of the price of gas and appliances on the gas sales are outlined as well as the effect of redistribution of incomes since the end of the second World War.

**What It Costs to Build a Pipeline.** G. Kinney. *Oil Gas J. 58,* 106 (1960) June 27 (4 pp.)

Actual cost figures reported to the Federal Power Commission are tabulated for all sizes of lines from 2 in. to 36 in. with breakdown of costs on right-of-way, materials, labor and miscellaneous. The figures are reported by laterals and main transmission lines to provide Federal Power Commission's own check on construction costs.

**The Scope and Philosophy of Regulatory Commissions.** A. S. Boyd. *Public Util. Fortnightly 65,* 909 (1960) June 23 (6 pp.)

Until a new method of regulation, superior to the present one, is devised commissions should continue. A commission is no better than the caliber of its staff; they have their faults and need improvement, but they are the best instrument yet found for controlling businesses vested with public interest.

**Why the Oil and Gas Industry Should Participate Actively in Politics During 1960.** *World Oil 150,* 116 (1960) June (7 pp.)

Voting records of potential presidential and vice-presidential candidates on major oil and gas issues are reported, plus an inside look at the voting records of thirty senators seeking reelection this year. At least ten issues vital to the oil and gas industry are discussed including: natural gas bill, percentage depletion, federal highway program, antitrust, fair trade bill, national fuels policy, oil imports, leasing bills, pipeline divorcement and others.

## Coke

**Coke in a Changing Market.** F. A. Burden and D. G. Rose. I.G.E. Communication No. 571; *Gas Times 94,* 49 (1960) June (3 pp.); *Gas World 151,* 945 (1960) June 4 (3 pp.); **Discussion.** *Gas World 151,* 1068 (1960) June 25 (5 pp.)

In problems of the fluctuations and changes of the coke market, the authors see features common to most commodity markets, but there are special difficulties arising from the fact that gas and coke present a complex example of products in joint supply. The fluctuations of supply and demand manifest themselves in stock movements that not only the public, but many within the industry, find hard to understand. Big changes are predicted in supplies and demand and also changes affecting the determination of the prices by which it is sought to equate the two factors.

## Compressor Stations

**Centrifugal Stations Lower Costs for Fiscal 1960.** G. Kinney. *Oil Gas J. 58,* 102 (1960) June 27 (4 pp.)

Average industry investment costs reported in the year ending this month are lower than 1959 due to abnormal number of centrifugal installations. Total installed centrifugal horsepower exceeded reciprocating horsepower by a wide margin during fiscal 1960. How construction costs are affected by location, type of drive, and whether the unit is a new station or an addition is indicated in a table.

## Drilling

**Future Progress in Production.** J. W. Williamson. *Petrol. Eng. (Drilling and Producing) 32,* B-19 (1960) June (8 pp.)

Exclusive interview with prominent research personalities in the U.S. petroleum industry is presented on up-to-date problems and progress of research and development activities.

## Exploration

**Geophysical Work Off Again in '59.** *Oil Gas J. 58,* 90 (1960) June 20 (2 pp.)

Geophysical activity in the free world last year was off 8.6% from 1958 with work reductions recorded in all the major areas except the Far East. Pace setters in the decline were Canada in the Western Hemisphere with a 25.6% drop in total geophysical work and Europe in the Eastern Hemisphere with a 14.5% drop. Western Hemisphere activity as a whole was off 5.1% and an even greater reduction of 14.5% occurred in the Eastern Hemisphere.

## Industrial Heating

**Development of the Industrial Gas Load in Scotland.** A. Higgs and R. W. Deans. I.G.E. Communication No. 570; *Gas Times 94,* 42 (1960) June (2 pp.); *Gas World 151,* 942 (1960) June 4 (3 pp.); **Discussion.** *Gas Times 94,* 57 (1960) June (3 pp.); *Gas World 151,* 1034 (1960) June 18 (3 pp.)

The Scottish Gas Board has functionalized its sales organization, and has given particular attention to its technical advisory service to industry in order to consolidate existing gas loads and accelerate the rate of development of new business. Cumulative effects of the improved industrial consumer service, and of a reasonably competitive tariff structure, are achieving the desired results. A comprehensive survey was made throughout the Board's area and the approach to securing new business is made on a planned basis. Initial attention was directed to producer fired process plant, proposals were formulated and submitted for conversion in a number of cases. All these efforts seem to have met with a measure of success.

## Foreign Activities

**Big Gas Line on Schedule.** M. S. Albans. *Pipeline Engineer 32,* D-19 (1960) June (5 pp.)

Gas line, 500-mile long and 24-in. in diameter, built by Petroleos Mexicanos, with only 150 miles to go, is scheduled to tap southern Mexico's big gas reserves at Pemex City before the end of the year. Thus, many of the ever-increasing number of industries in the Federal District and adjoining states of Hidalgo and Mexico will be burning natural gas for the first time.

## Petrochemicals

**The Mexican Approach to Petrochemicals.** F. L. Sosa. *Chem. Eng. Progress 56,* 50 (1960) June (2 pp.)

Survey of Mexico's petrochemical potential, pointing up oil resources, producing zones and refining centers is presented.

### Pipeline Construction

**Trans-Mediterranean Gas Line Studied.** *Oil Gas J. 58,* 87 (1960) June 13.

Engineering studies are in progress for a proposed natural gas pipeline across the Mediterranean Sea from North Africa to Sicily. A detailed study of the bed of the 77-mile wide Sicilian Channel is starting this month. Italian groups backing the project expect to know by this fall whether their plan is feasible. Earlier this year, Conch International Methane, Ltd. and Union Stockyards of Chicago made a preliminary agreement with the French for a gas liquefaction plant on the North African Coast. The French have a 24-in. gas line system under construction that will start supplying local consumers next year.

### Process Design

**Process Equipment Costs in Mexico.** *Chem. Eng. Progress 56,* 76 (1960) June (4 pp.)

How to figure installed costs of chemical processing equipment in Mexico is described. Case history data on fabrication, erection costs, and import tariff rates are given.

**Mexican Plant Cost Estimation.** P. Larraza. *Chem. Eng. Progress 56,* 41 (1960) June (3 pp.)

Successful estimation of investment costs for process equipment is a complex problem to solve in Mexico. The reason is that there is not a sufficient number of companies properly organized for the fabrication of equipment which has been predesigned and which is subject to the codes and specifications required in each case. Evaluation of project investment depends, therefore, on careful estimation of process equipment costs, both domestic and imported.

### Safety

**The Big Five of Safety.** E. H. Eacker. *Gas Age 125,* 27 (1960) June 23 (3 pp.)

Boston Gas Company's safety program has earned a 1.98 accident frequency rate, 75% below the national average of the gas industry and 80% below the average of industry across the nation. Only eight lost-time accidents occurred among 1900 employees over the entire year, and an impressive stretch of over two million consecutive man hours without a lost-time accident in 1959 was recorded.

**Compressor Explosion.** C. W. Gibbs. *Chem. Eng. Progress 56,* 64 (1960) June (4 pp.)

Investigation of damage caused by an explosion during a routine test of a centrifugal booster compressor warns operators against explosive oil-air mixtures. Recommendation was made, and immediately put into effect, that an inert gas, which will not support combustion, be used in place of air in all future testing of centrifugal compressors where it is possible for combustible materials to enter the closed loop.

**Minimizing Radiation Hazards.** L. J. Cherubin. *Chem. Eng. 67,* 105 (1960) June 27 (6 pp.)

In order to dispel some of the mystery surrounding radiation effects, the author discusses some aspects of radiation and human health, and industrial methods of measuring and monitoring. The article is limited to situations a person might encounter when working in a plant handling or processing nuclear materials (liquids or solid).

**Oxygen Plant Reboiler Explosion.** R. W. Rotzler, J. A. Glass, W. E. Gordon and W. R. Heslop. *Chem. Eng. Progress 56,* 68 (1960) June (6 pp.)

In January 1956, a reboiler explosion occurred in the large tonnage oxygen plant of Monsanto Chemical Co. at Texas City. Reboiler tubes were extensively damaged and trays in the associated distillation column were displaced. Laboratory study of plant clues indicate a co-crystal of acetylene and nitrous oxide, which built up over a six-month period at the bottom of the reboiler, caused the plant mishap.

**Safety in Air and Ammonia Plants.** *Chem. Eng. Progress 56,* 73 (1960) June (3 pp.)

A serious accident occurred in April, 1959 in a 240-ton/day oxygen plant which was being started up in Billingham, England. Without any warning, one corner of the coldbox was wrecked by an explosion. Although the actual explosive charge was small, the damage was quite extensive. This plant has turbo-expanders with gear assemblies mounted on bases just outside the coldbox wall in the compression plant. Oil had dripped occasionally from these gear assemblies on to their bed plates. Some of the oil seeped into a narrow crevice between the expander assembly mounting base and the coldbox wall. It is to be remembered that mixtures of liquid oxygen and oil are so sensitive that even the vibration of the ground can be sufficient to set them off. More case history data and off-the-record discussions are presented.

**How to Tame a Sample Bomb.** J. C. Ducommun. *Oil Gas J. 58,* 123 (1960) June 20 (3 pp.); **Sample Bombs Can Be Bombs.** *Petrol. Refiner 39,* 231 (1960) June (2 pp.)

At Standard Oil Co.'s refinery laboratory a bomb of 1900 ml capacity ruptured, releasing butane vapors which flashed. The bomb involved was thought to be stainless steel, but later found to be low carbon steel. Design pressure rating was 50 psi and the working pressure rating was 400 psi. The bomb was placed in a shaker to assure that ethylene glycol would mix thoroughly with the butane sample absorbing moisture from the butane. During the shaking, the bomb ruptured, releasing the contents which vaporized and flashed. It appears that thermal expansion of the contained liquid, resulting from the 49°F rise in temperature, could have subjected the bomb to a pressure of at least 1000 psig.

**Safely Operating that Low Temperature Plant.** *Chem. Eng. Progress 56,* 37 (1960) May (21 pp.); **Air Intake Impurities.** *Ibid.,* 37 (1960) May (2 pp.); **Compressors and Dampeners.** *Ibid.,* 38 (1960) May (4 pp.); **Hydrocarbon Adsorbers.** *Ibid.,* 41 (1960) May (2 pp.); **Reboilers and Vaporizers.** *Ibid.,* 42 (1960) May (3 pp.); **Construction Practices.** *Ibid.,* 44 (1960) May (3 pp.); **Instrumentation Application.** *Ibid.,* (1960) May (3 pp.); **Repairs and Shutdowns.** *Ibid.,* 48 (1960) May (3 pp.); **Hydrogen Production.** *Ibid.,* 50 (1960) May (2 pp.); **Ammonia Plant Compressors.** *Ibid.,* 51 (1960) May (4 pp.); **Ammonia Storage.** *Ibid.,* 54 (1960) May (3 pp.); **Materials of Construction.** *Ibid.,* 56 (1960) May (2 pp.); **Compressor Explosion.** C. W. Gibbs. *Chem. Eng. Progress 56,* 64 (1960) June (4 pp.); **Oxygen Plant Reboiler Explosion.** R. W. Rotzler, J. A. Glass, W. E. Gordon and W. R. Heslop. *Ibid.,* 68 (1960) June (6 pp.); **Safety in Air and Ammonia Plants.** *Ibid.,* 73 (1960) June (3 pp.)

All reports mentioned were presented at the Air-Ammonia Safety Symposium at St. Paul, Minn. Since the opening of the first commercial air liquefaction plant, there probably have been hundreds of major accidents in units of this kind. Generally, the causes have centered around relatively few specific conditions. First, the particular properties of acetylene; second, the marked increase in the activity of oxygen at high concentrations; and third, the low temperatures involved which erect barriers to detecting and correcting unusual conditions. These articles represent case studies of actual accidents. Interrelationship between various safety aspects of a plant are outlined.

### Space Heating

**The Architect and the Gas Engineer.** R. B. Hellard. I.G.E. Communication No. 569; *Gas Times 94,* 43 (1960) June (2 pp.); *Gas World 151,* 936 (1960) June 4 (2 pp.); *Gas J. 112,* 518 (1960) June 22 (5 pp.); **Discussion.** *Gas Times 94,* 55 (1960) June; *Gas World 151,* 1037 (1960) June 18 (2 pp.)

Appreciation of the many and varied services which the architect is called upon to provide is given. The author has adopted the approach to the choice of heating equipment by taking account not only of capital costs but also of the operation and maintenance costs of the equipment over a period of years.

**Gulf-Designed Oilburner Contains Two New Ideas.** J. W. Schulz. *Fueloil & Oil Heat 19,* 43 (1960) June (5 pp.)

Gulf scientists explain the basic concepts of an air-aspirating nozzle which utilizes an air pump to perform the functions served in an unusual burner by its oil pump and blower wheel. Other amazing forms of fuel oil combustion are demonstrated such as the "flame tube," a perforated stainless steel tube, developed especially to work in conjunction with the air-aspirating nozzle. Burners of this type feature flameless combustion, emission of vast amounts of heat and immaculate cleanliness.

## 2. ENERGY SUPPLY AND ECONOMICS

### Reserves

**Reserve Evaluation.** E. A. Hartsook. **Part 1.** *Oil Gas J. 58,* 136 (1960) June 20 (3 pp.); **Part 2.** *Ibid.,* 126 (1960) June 27 (3 pp.)

Importance of economic elements to the accuracy and adequacy of reserve valuations, whether the valuation is made to establish a price base or to pinpoint development strategy, are discussed. The author outlines some of the pitfalls lurking behind precise techniques of investment rates of return and discusses some questions on interest rates for analytical purposes. Part 2 covers price factors, production assumptions, interest rates, payout requirements and tax factors which contribute an integral part to reserve valuation.

### Energy Sources

**Patman Inquiry May Affect Oil and Gas Policy.** J. Huttlinger. *Pipeline News 32,* 19 (1960) June

Rep. Wright Patman, (D., Tex.) chairman of a joint economic subcommittee on energy resources, asked scores of federal and state agencies for specific information as to what they do in the field of energy and what recommendations they may have to improve their work. The Patman study could lead to recommendations as to the income tax depletion allowance, a natural gas bill, oil import controls, the interstate oil compact, and industrial sales of natural gas or a national fuels policy.

**Can We Salvage Another 44 Billion Barrels?** P. D. Torrey. *Oil Gas J. 58,* 97 (1960) June 13 (6 pp.) *Petrol. Eng. (Drilling and Producing) 32,* B-52 (1960) July (5 pp.)

This report on U.S. oil resources represents a continuation of studies which have been made periodically by the Secondary Recovery and Pressure Maintenance Committee. These studies are made to determine the amount of oil discovered in the fields of U.S. and the amount which will be recovered from them. This year's report has a feature not found previously; the additional oil that may be recovered by new processes, such as thermal recovery and solvent extraction. There are uncertainties connected with the possible extent to which these new processes may be applied, and with the measure of their effectiveness, but the methods appear to hold enough promise to include their effect on the nation's future oil production.

### Fuel Cells

**Oxygen Overpotential in Molten Carbonates.** G. J. Janz, F. Colom and F. Saegusa. *J. Electrochemical Soc. 107,* 581 (1960) July (6 pp.)

Overvoltage of the oxygen evolution reaction on Pt electrodes was measured in a ternary mixture of molten $Na_2CO_3$-$Li_2CO_3$-$K_2CO_3$ with current densities up to 50 ma/cm$^2$ and temperatures up to 1000° C. Two well distinguished regions in the overvoltage-log current density relation are observed. At current densities less than 1 ma/cm$^2$ the marked dependence of the oxygen over-

potential on the composition of the gas flow and on temperature are characteristic of a concentration-type overpotential most probably due to the build-up of oxide ion in the melt. In the range of about 1-50 ma/cm², the oxygen overpotential seems activation controlled.

### Electricity

**How Soon Electric Heating?** G. T. Kellogg. *Public Util. Fortnightly 65,* 820 (1960) June 9 (10 pp.)

Electric industry, still concerned with solving some of the electric home heating problems, will welcome any system that will do an efficient job for its customers because it realizes electric heating will help level its high summer air-conditioning peaks. The heat pump may prove to be the best all-around answer. Should some other method be found superior, however, the electric industry will promote it. It is estimated that by the end of 1970, more than four million space-heating customers will be served by electric utilities.

**Meeting Tomorrow's Power Needs.** A. S. King. *Public Util. Fortnightly 65,* 793 (1960) June 9 (5 pp.)

The population explosion predicted for the next 20 years will pose no problem for the investor-owned electric utilities. They will prove themselves ready and able to supply the power needs of the nation efficiently and inexpensively. Steam-produced power seems destined to hold its lead, with hydro-electric power as second. But nuclear power seems almost certain to overtake and exceed hydro power by 1980. Whatever tomorrow brings in electricity demand, the ingenuity of the industry will be sufficient to meet it.

**Design and Application for Electric Heat.** P. Sporn and E. R. Ambrose. *Air Conditioning, Heating and Ventilating 57,* 78 (1960) July (11 pp.)

During the past few years, electric space heating has had a high rate of growth. Unquestionably, electric heating has materially improved competitively. It has been found that the higher electrical energy cost ceases to be a dominant factor if the many favorable design and application practices are effectively utilized. While at present most of the installations have been made in residences, there is growing usage in schools, motels and commercial installations. Article covers the various forms of electric heat being used, and economical design practices.

### Petroleum

**Business Signs Point to an Economic Upswing for Oil in the Second Half.** *Petrol. Week 10,* 27 (1960) June 17 (3 pp.)

Outlook for the second half of 1960 seems to be promising. It may rise as much as 4.8% over the second half of 1959. This would mean an average of about 10 million bbl/day for the year as a whole, an increase of 3.3% over 1959. Drilling, production and demand are expected to perk up, but competition will increase.

**World-Wide Competition Sharpens Oil Paradox.** E. Adams. *Pipeline Engineer 32,* A-21 (1960) June (34 pp.); *Petro/Chem Eng. 32,* A-21 (1960) June (34 pp.)

Petroleum activities in 125 countries and areas are reviewed in this annual survey of world-wide operations.

**Conditions Call for Cut in Oil Imports.** *Independent Petrol. Assoc. Monthly 31,* 17 (1960) June (3 pp.)

While expressing disappointment over government's failure to cut back imports now, there is reason for encouragement in Interior's statement that it is keeping the import level and the use of estimated demand under continuing review. In the last five years the demand for crude oil has shown no increase. The impact of this condition is reflected in substantial reduction in state oil production allowables. The number of producing days in Texas has declined from 190 in 1956 to 123 in 1959. During the first five months of 1960, the number of producing days has again declined sharply, totaling only 47 compared with 58 during the same period in 1959.

### Solar Energy

**Thermoelectric and Mechanical Conversion of Solar Power.** R. C. Schlichtig and J. A. Morris. *J. Solar Energy Sci. Engng. 3,* 14 (1959) April (4 pp.); (From *Appl. Mech. Rev. 13,* 436 (1960) June)

It has been frequently demonstrated that solar energy can produce power by its direct heating effect. It has previously been overlooked, however, that sunshine stores vast amounts of free energy in the atmosphere by lowering its relative humidity, particularly in desert areas. The presently described equipment is a composite of a solar collector, a thermoelectric generator, and a mechanical converter which will generate power from waste heat and stored free energy of dry atmospheric air, although the mechanical converter is described as associated with a reflecting solar collector.

### Tar Sands

**Water Washing of Tar Sands.** C. E. Hemminger (assigned to Esso Research and Engineering Co.) U. S. 2,940,919 (1960) June 14.

The present invention deals with a process for recovery of hydrocarbons from tar sands by aqueous washing. The solids are passed downward over screen baffles countercurrent to a rapid flow of water. The treated, settled sands are passed to a combined dryer and furnace and a fluidized combustion zone in which air is used to burn the residual traces of oil in the sand. The furnace heat is utilized to heat the wash water.

### Thermoelectricity

**Potential Heat in Fuel: Direct Conversion to Electricity.** M. W. Thring. *J. Inst. Fuel 33,* 294 (1960) June (6 pp.)

Electricity was generated from fuel for many years by the steam cycle, the gas turbine cycle and the internal combustion engine cycle, but overall efficiency of all these processes is limited by the upper temperature available. Direct processes involve the fuel cell, thermoelectric generation and electric gas braking. A number of interesting fuel cells are being developed, but none of them at the moment seem likely to be an efficient and economical method of primary electricity genera-

tion from fuel. Thermoelectric methods of generation are limited at present by the properties of known materials to efficiencies which are considerably lower than that of the classical cycles. With electromagnetic gas braking, the difficulty is to obtain a sufficiently high gas conductivity after the adiabatic temperature drop in the expansion nozzle. Methods proposed for overcoming this difficulty are the use of a striated system with alternate layers of high conductivity gas and working fluid, and the use of pulsating combustion to give combustion at effectively constant volume instead of constant pressure.

**A Comparative Study of the Manufacturing Costs of the Thermoelectric and Mechanical Refrigerating Systems.** D. W. Scofield, P. F. Taylor and L. A. Staebler. *ASHRAE J. 2,* 37 (1960) July (5 pp.)

Increased use of thermoelectricity may in the future have applications for devices of capacities up to 200 Btu/hr and within just a few years make available thermoelectric refrigerators of up to four cu ft despite competition of the low cost mechanical refrigerating system. The authors compare the manufacturing costs of these two systems which combine improved thermoelectric materials, simplified manufacturing techniques and low cost power supplies. How thermoelectric refrigeration could be economically competitive with mechanical refrigeration for several major large appliances is discussed.

**Thermoelectric Power.** E. V. Somers and J. C. R. Kelly. *Mech. Eng. 82,* 40 (1960) July (3 pp.)

Thermoelectric power is a simple and competitively efficient way to provide power for a number of small and intermediate loads. Efficiency of a thermoelectric plant, although not competitive with modern central power stations, may become sufficiently high to establish it as a useful peaking complement to a central power station.

## 3. NATURAL GAS AND PETROLEUM PRODUCTION

### Drilling

**Air-Hammer Drilling in the Permian Basin.** H. F. Downs. *Petrol. Eng. (Drilling and Producing) 32,* B-90 (1960) June (5 pp.)

Author reports on airhammer drilling evaluations and describes five wells located in the Permian Basin of West Texas. Where direct comparisons are available, it is concluded that penetration rates may be doubled by the use of the airhammer with occasional drilling rates three to four times greater than rotary airdrilling. Reduction in deviation by airhammer drilling is credited with excellent results. Airhammer bit footage was extended in specific instances and overall averages indicate much greater footage per bit may be expected.

**Fly-In Rig Speeds Up Bolivian Exploration.** *Petrol. Eng. (Drilling and Producing) 32,* B-58 (1960) June (3 pp.)

An unusual drilling rig especially designed for use in airborne exploratory drilling operations in Central Bolivia is being assembled in Houston, Texas. The weight of the complete drilling rig less pipe, supplies and camp is under 400,000 lb or about half that of a comparable horsepower conventional rig. This weight saving was accomplished without sacrificing rig efficiency. Other important objectives in the design of this rig are: flexible control, dependability, portability and ease of rig up.

**How Blowouts Are Affected by: Company Policy, Drilling Breaks and Mud Weight to Kill Kicks.** T. B. O'Brien and W. C. Goins, Jr. **Part 1.** *Oil Gas J. 58,* 103 (1960) June 20 (5 pp.); **Part 2.** *Ibid.,* 123 (1960) June 27 (3 pp.); **Part 3.** *Ibid.,* 110 (1960) July 4 (5 pp.); **How to Control Blowouts. Part 1.** *World Oil 150,* 97 (1960) May (6 pp.); **Part 2.** *Ibid.,* 123 (1960) June (4 pp.); **Part 3.** *World Oil 151,* 111 (1960) July (5 pp.)

Part 1 of this three part series is one of the most important contributions of recent years to the knowledge of blowouts. It is shown what the oil company and contractor can do to create a climate of security against blowouts, and also shows how flow rates, so important to proper well control, can be calculated. The second article covers a method for killing blowouts which threaten during drilling, and the third tells how to control kicks while making a trip.

**Drilling Outlook Remains Good.** G. R. Thomas and E. Nosow. *World Oil 150,* 95 (1960) June (6 pp.)

United Fuel Gas Co.'s deep drilling program continues to hold the spotlight in eastern Kentucky. Virginia activity continues in Wise, Dickenson, and Buchanon counties. In West Virginia, 481 wells were drilled from June 1, 1959 through May 1, 1960. Complete details on drilling activity in these three states, an up-to-date oil and gas field map, cross-section of the first basement test drilled in eastern Kentucky, plus an informative discussion of the completion and drilling methods used in this area is given.

### Drilling Muds

**How to Get the Most From Your Gyp-Spersene Muds.** J. F. Youngblood. *Drilling 21,* 52 (1960) June (2 pp.)

Gyp-Spersene mud is finding wide application in today's drilling because of its versatility and high performance. Simple to prepare and easy to maintain, it resists contamination by salt, cement, and anhydrite and provides an inhibiting environment. Gyp-Spersene mud will remain reasonably stable for long periods of time at high temperatures. It is easily converted to surfactant mud when extreme temperatures are encountered in the well bore.

### Exploration

**Alberta Adds Gas Discovery.** *Oil Gas J. 58,* 177 (1960) June 20

Deep drilling along southwestern Alberta's Foothills has come up with another Mississippian gas discovery at a surprisingly relative shallow depth for this western Canada trend of fields. The discovery was made by Texas Gulf Sulphur Co. group operator, at its Wild-

horse Creek wildcat in the Burnt Timber-Panther River region. It is 60 miles northwest of Calgary and about 30 miles north of Banff.

**Appalachian Rim Is Likely Area.** D. M. Young. *World Oil 150,* 104 (1960) June (2 pp.)

Prospects for future oil and gas development in Virginia are to be found in the Appalachian or Cumberland Plateau area in the southwestern part of the state. It is possible that the Oriskany gas production of Rockingham County might be extended northeast or southwest. It is also conceivable that some production might be obtained in other parts of the Valley and Ridge province. With current emphasis on the Appalachian area and eastern U.S., further testing of the Coastal Plain might be undertaken.

**Deep Tests Reflect Near-Peak Gas Yield.** A. J. W. Headlee. *World Oil 150,* 100 (1960) June (5 pp.)

More than 2000 wells were completed in West Virginia during the past 30 months. Success in finding new gas production has caused the state's current natural gas yield to approach the all-time high set in 1900. The author gives a summary of current developments and deep exploration in this area.

**Key Development Years Just Ahead.** H. C. Milhous. *World Oil 150,* 92 (1960) June (4 pp.)

Recent increase in exploration in Tennessee is a result of new production in southern Kentucky, but new leasing has affected about three-fourths of Tennessee's area. The amount of acreage already under lease and the number of companies involved indicate that the next year or two should be the most important for oil and gas development in Tennessee so far. Further discoveries, especially of shallow oil, probably will be made in the near future by the numerous independent and several major companies as the favorable lease blocks are tested.

**Oil and Gas Search at All-Time Peak.** H. N. Toler. *World Oil 150,* 82 (1960) June (7 pp.)

At the present time and for the past two years, the search for oil and gas in Mississippi and Alabama has experienced perhaps its most active period. Now after considerable success in finding good reserves of both oil and gas in the Lower Cretaceous, the interest is about evenly divided between the Upper and Lower Cretaceous. The average depth to which wells are being drilled is progressively increasing and this increase will continue as long as potentially oil producing beds lie untested at greater depth.

**Oil and Gas Potential a Question Mark.** J. T. Singewald. *World Oil 150,* 112 (1960) June (2 pp.)

There are three distinctly different geologic provinces in Maryand: Appalachian Province, Piedmont Province and the Coastal Plain. The author presents a timely report on the oil and gas possibilities and geology of these areas, plus a brief history of drilling and production in the state.

## Logging

**Nuclear Logging in the Appalachian Basin.** R. M. MacFarlane and R. K. Ault. *World Oil 150,* 153 (1960) June (4 pp.)

Nuclear logging techniques at present are applied to both wet and dry bore holes in the Appalachian Basin. The single neutron curve is used for determination of porosity and delineation of subsurface formations, and the gamma ray log can be used for correction of neutron response when determining porosity in shaley formations. Double spaced neutron log has been useful in determining whether the formation of interest is liquid filled or gas filled. Specific applications of nuclear logging in the Appalachian Basin area are outlined.

## Reservoir Engineering

**Thermal Characteristics of Porous Rocks at Elevated Temperatures.** W. H. Somerton and G. D. Boozer. *J. Petrol. Tech. 12,* (Tech. Note 2061) 77 (1960) June (5 pp.)

Thermal diffusivities of some typical sedimentary rocks were measured by a rapid unsteady state technique. Thermal data including diffusivity and conductivity are presented for the temperature range of 200° to 1800°F. Diffusivities calculated from steady state conductivity measurements compared favorably with unsteady state data at the lower temperatures. Unsteady state data are less reliable at higher temperatures; reported values may be as much as 20% high at temperatures in excess of 1500°F. This is caused partly by the simplified method used in calculating diffusivity from experimental data and partly by the many thermal reactions which occur at the higher temperatures.

## Well Practice

**How France Produces High-Pressure Gas Wells.** H. T. Brundage. *World Oil 150,* 167 (1960) June (2 pp.)

France's unique, deep Lacq gas field, which produces gas with 16.8% hydrogen sulfide from 11,500 to 14,000 ft depths, is being successfully produced with dual concentric strings of alloy tubing. Inner annulus is filled with corrosion inhibitor treated with diesel fuel. Experimental tapered tubing strings may increase the productivity. Success of this technique is proving vital to France, allowing utilization of this toxic, high-pressure wet gas reserve.

**The World's First Quintuple Producer.** *World Petroleum 31,* 56 (1960) June (3 pp.); **First Quintuple String Completion.** *Petrol. Eng. (Drilling and Producing) 32,* B-32 (1960) June (3 pp.); **How Sinclair Completed Its Quintuple String Well.** *World Oil 150,* 128 (1960) June (5 pp.)

Sinclair Oil & Gas Co. has completed the oil industry's first quintuple producer, 40 miles off the coast of St. Mary Parish, in the Gulf of Mexico. Five parallel 2-in. tubing strings with six packers were run inside the 9⅝-in. casing. Sinclair has completed the well in six zones, five of which may be produced simultaneously. The discovery well was drilled in 72 ft of water.

## 4. GAS CONDITIONING AND LPG RECOVERY

### Dehydration

**Gas Treating Apparatus and Method.** W. E. Gifford. U. S. 2,935,856 (1960) May 10.

A gas dryer is claimed comprising a central finned tube fitted tightly within a tube of larger diameter to form a subdivided annulus. The tubes are open at the upper end, where a refrigerating coil is wrapped in a tight helix. The coil and upper tube are sealed by an enlarged dome. The helix is more loosely wrapped around a long lower portion of the tube. Wet gas injected at the bottom rises, loses its moisture as ice and rises in the annulus where it is withdrawn as dried gas from the central downcomer tube. Ice is intermittently melted out of the annulus by stopping tbe refrigerant flow.

### Dust Removal

**Correlation of Dust Scrubber Efficiency.** K. T. Semrau. *J. Air Pollution Control Assoc. 10,* 200 (1960) June (8 pp.)

Method of correlation is applied to literature data for a variety of aerosols and scrubbing equipment. Correlation of literature data generally confirms the findings of the earlier studies on the relationship of efficiency and contacting power. Efficiency is found to have little relation to scrubber design and geometry, but to be dependent on the properties of the aerosol and on the contacting power. There are few data to show the effect of scrubber size, but a number of the studies report that there are essentially no scale effects.

### Hydrocarbon Recovery

**Buying and Operating Short-Cycle Units.** *Oil Gas J. 58,* 113 (1960) June 13 (2 pp.)

Shell Oil's experience shows that short-cycle adsorption units provide a dependable method for dehydration and recovery of hydrocarbons from high pressure gas streams. Application should, in general, be limited to low volume lean gas streams. Attractive payouts can be realized with these units if properly applied and operated. Most operating difficulties were of a mechanical nature and were solved by modifying the equipment used.

**How Adsorption Units Are Operating.** H. Halff. *Petrol. Refiner 39,* 197 (1960) June (4 pp.)

Texaco's short-cycle adsorption units for gas processing are now operating in a routine manner. But behind this development are numerous problems which had to be worked out. Eleven points which Texaco had to consider in the development of adsorption units are: application, selection and bid evaluation, control systems, heaters, desiccant, mechanics, accessibility, pressure protection, cycle time, performance guarantees, and operating records.

### Hydrogen Sulfide Removal

**Equilibrium Pressures of Hydrogen Sulfide and Carbon Dioxide Over Solutions of Potassium Carbonate.** J. S. Tosh, J. H. Field, H. E. Benson and R. B. Anderson. *U.S. Bur. Mines Rep. Invest. 5622* (Pittsburgh: The Bureau, 1960.)

Equilibrium of the system potassium carbonate, potassium bicarbonate, potassium bisulfide, carbon dioxide, hydrogen sulfide and water. Partial pressures of hydrogen sulfide, carbon dioxide and water were measured at 70° to 130°C over solutions of 20%-, 30%-, and 40%-equivalent potassium carbonate containing from 20 to 3000 grains of equivalent hydrogen sulfide per gal of solution. This study was made to obtain equilibrium data for evaluating the feasibility of using solutions of hot potassium carbonate for removing hydrogen sulfide from gas mixtures. Equilibrium data show that effective removal of both carbon dioxide and hydrogen sulfide can be achieved simultaneously with hot solutions of potassium carbonate.

**Sour-Gas Problems Are Under Attack.** *Petrol. Week 10,* 35 (1960) June 24 (2 pp.)

Approval of gas exports from Canada has focused increased attention on the solution of problems associated with development of sour-gas reserves. A recent study by the Alberta Oil & Gas Conservation Board shows that there are 65 areas in the province in which the hydrogen sulfide content of natural gas exceeds 5%. The latest development involving sour-gas fields is a multimillion-dollar plan for gas processing facilities to serve three Alberta fields jointly. One example of how high hydrogen sulfide content in gas is being curbed is the producing system set up in the Okotoks field.

## 5. NATURAL GAS TRANSMISSION

### Automation

**Automated Holder-Compressor Station Goes into Operation.** *Gas Age 125,* 17 (1960) June 9 (2 pp.)

Long Beach, Calif., gas department installed the world's largest Wiggins type holder and a compressor station featuring an octagonal design and full automation in effort to keep pace with the gas demand.

**Electronic Control of Pipeline.** P. H. Drinker. *Instruments and Control Systems 33,* 972 (1960) June (4 pp.)

Author describes how new electronic control instruments can handle seven unusual and particular requirements of pipeline applications with superior performance, reliability and convenience. These techniques (automatic selection of controllers in multivariable systems, anti-windup for rapid control action, and function generators for start-up) also are useful in critical chemical reactions, protective circuits, batch processes, heat-exchange processes and so on.

**Future Automation in Gas Pipelines.** L. R. Henry. *Gas Age 125,* 20 (1960) June 23 (6 pp.)

Automation in future control systems is described by the author for other pipeline elements as well as compressor stations. Automation can do much of the routine work in dispatch centers to help the dispatcher make his load decisions. In well switching operations, a flow controller and remote radio operation of wells would act together to help the dispatcher. Automatic well scheduling is another possibility mentioned.

**What Management Expects from Automation in the Gas Pipeline Industry.** S. Orlofsky. *Pipeline News 32,* 24 (1960) June (2 pp.)

On the basis of the good performance of the Stanton compressor station, Columbia Gulf Transmission Co. designed and constructed five automatic, remotely controlled mainline stations. Each automatic station consists of four centrifugal compressors. The gas control center at Nashville has the ability to direct the running conditions of the five automatic stations and receive pertinent operational data from other key locations on the pipeline. The benefits that Columbia Gulf has gained through automating its system are summarized.

**Newest Control Idea: Local Automation, Remote Supervision.** *Pipe Line Ind. 12,* 55 (1960) June (5 pp.)

Colorado Interstate Gas Co. inaugurated formal use of a control system which eliminates any possible trouble that could come from an outage of a communication system, yet, at the same time, preserves the very purpose of the communication system. Local automation handles all operations at the compressor station and local instrumentation — primarily solid state — selects engines for service on the line, starts them, controls their speed, takes them off the line, and so on. Meanwhile, the dispatcher exercises supervisory control over the station via microwave radio. Yet, if the communications should fail, the station will continue to operate under local automation with closed circuitry.

**Pump Station Operates Unattended Without Communications.** R. D. Pfluger. *Pipe Line Ind. 12,* 48 (1960) June (7 pp.)

Automation of petroleum pipeline pump stations was controlled by facilities which bring the control of several pump stations within reach of one central operator. However, from an operations viewpoint, this method has several weaknesses: vulnerability of control to communications and remote equipment outages as well as excessive burden on the central operator. In order to eliminate these problems a power level controller was used with built-in control to select pumps, power levels and minimize throttling and surges.

**Remotely Supervised Automatic Compressor Station in Service.** *Gas Age 125,* 30 (1960) June 9 (2 pp.)

First remotely supervised automatic compressor station for a natural gas transmission company was placed in service by Colorado Interstate Gas Co. The system supervises the Springfield compressor station and gives pushbutton control over a 160 mile range.

## Communications

**Transmission Problems in using Normal Telephone Facilities at Frequencies Up to 400 Kilocycles.** E. E. Combs. *Pipeline News 32,* 40 (1960) June (6 pp.)

Development of higher frequency carrier channeling equipment led to the use of many frequency allocations and new techniques to obtain satisfactory equipment operation. However, new and formidable problems became apparent when applying high frequency channeling equipment to wire lines. Methods and practices in common use in telephone plant for frequencies up to 160 kc were found to be inadequate for the higher frequencies. This inadequacy embraces three general areas: 1) open wire line transportation schemes, 2) networks required to separate groups of frequencies and to match impedances, and 3) practices pertaining to the use of cable, twist, drop wire and switchboard wiring.

## Compressor Stations

**The Design and Operation of an Axial Flow Compressor Station.** J. D. Cormack. **Part 1.** *Gas J. 302,* 271 (1960) May 18 (4 pp.); **Part 2.** *Ibid.,* 335 (1960) June 1 (6 pp.)

A brief description of the Birmingham high-pressure system together with the circumstances which led to the development of the Washwood Heath station assists in placing the significance of the station in perspective. Part 2 illustrates automatic bypass control equipment used. Performance and total power requirements are discussed.

**Small Turbines.** *Pipeline Eng. 32,* D-26 (1960) June (4 pp.)

Pipeline industry is seriously considering greater use of small turbines. Savings in unit cost, station construction, maintenance and operations are the attractions. Several new designs, some of them quite unusual, have come out of manufacturing plants and are being installed on pipeline systems to test their effectiveness in actual use. Results may have an influence on future prime mover selection.

**Tennessee Gas Installs Its First Unitized Stations.** C. A. Falkenhagen, Jr. *Pipeline Eng. 32,* D-30 (1960) June (3 pp.)

Primary considerations in designing four compressor stations for the Tennessee Gas Pipeline Co. were safety, low maintenance and operational costs as well as compactness. The stations were constructed during the latter part of 1959 on a 30-in. system carrying gas from the Louisiana coastal area to Sumner County, near Portland, Tennessee. They are approximately 120 pipeline miles apart and have a total of 31,000 hp. Working pressure of the system is 940 psig.

## Fluid Flow

**Argon-41 Measures Natural-Gas Flow.** D. V. Kniebes, P. V. Burket and W. R. Staats. *Nucleonics 18,* 142 (1960) June (5 pp.)

It is important to maintain smooth inner surfaces in transmission lines. Periodic flow tests detect sections that need cleaning. The usual test uses an injection of ammonia as a tracer and detects its arrival ten miles downstream from the injection point with a color sensitive pH indicator. The drawbacks of this method are outlined. Therefore, a tracer test which uses $A^{41}$ and a scintillation detector was developed. Although the short half-life of $A^{41}$ is a disadvantage, the method is safe and accurate; it is capable of checking on the ammonia method and offering some additional information.

### Metering

**Automation Trends in Orifice Meter Measurement and Gas Dispatching.** G. J. Sandusky. *Gas Age 125*, 15 (1960) June 23 (5 pp.)

Description of the wide rangeability of the orifice meter can be most effectively exploited through automation, including a review of electronic computers and their ability to automatically reduce orifice meter data to volumes in terms of standard conditions. The full rangeability inherent in orifice meters can be substantially achieved automatically by the installation of multiple orifice meter runs controlled by differential limit flow controllers that operate control valves to cut in or out additional tubes as needed. Another metering device is the multiplex fitting, which is an orifice fitting holding a large rotating disk with no less than five different orifices.

### Pipeline Construction

**Alaska's Prototype Pipeline.** R. E. Nance. *Pipeline Eng. 32*, D-24 (1960) June (2 pp.)

A steel tube, 8-in. in diameter, which snakes its way over and under 626 miles of Alaskan and Canadian terrain has proved itself an efficient and vital link in transportation facilities that service the unified Alaskan Command. With the oil search getting to be more intense in the 49th state, the Alaskan Command's military complex may serve as a model for future pipelines.

**Along the Right-of-Way Condemnation Preparation.** F. M. Diamond. *Pipeline News 32*, 31 (1960) June (4 pp.)

Problem of preparing for condemnation is summarized. Preparation starts with a fair offer to the landowner. Other very important functions in preparing a case for condemnation are the investigation of comparables in detail, obtaining aerial oblique photographs, selecting appraisers and consultants, and following the technical evidence.

**Helicopter Speeds Stringing on Trunkline's Marsh Work.** D. G. DePugh. *Pipeline Ind. 12*, 36 (1960) June (2 pp.)

When marsh mud coupled with a lack of access roads made it virtually impossible to string pipe on a short section. This obstacle was overcome with helicopters, which made it possible to finish the job even several days earlier. Another advantage was that the helicopter method cut stringing costs.

**Pipe Lining Apparatus.** W. E. Perkins, A. J. Perkins and R. J. Szpakowski (assigned to Perkins Pipe Linings, Inc.) U.S. 2,935,777 (1960) May 10

This invention relates to an apparatus for applying a protective coating of mortar or like material to the inner walls of pipelines, conduits and the like, and more particularly to motion control facilities which prevent twisting and maintain axial alignment and uniform speed of the machine during travel. Twisting is avoided by a sharp edged guiding wheel, mounted on a yoke linked to a pendulum which causes increased wheel friction against side motion. The pull of the winch in turn transmits motion to traction wheels through a flywheel, but the latter is controlled by a speed governor.

**Transwestern's Operation and Design Features.** B. Quarles. *Pipeline News 32*, 35 (1960) June (4 pp.)

Engineering, design and construction innovations on the new gathering and transmission network of the Transwestern Pipe Line Co. are so numerous that regular features on the system are as conspicuous as deviations from standard practices on other projects. Most marked departure from existing pipeline systems are outlined covering: central controls, design development, construction problems, compressor stations, and coating and cathodic protection.

### Propane

**Propane by Pipeline.** F. B. Neptune and M. K. Neptune. *Pipeline News 32*, 20 (1960) June (4 pp.); **Propane by Pipeline.** *Butane-Propane News 22*, 68 (1960) July (2 pp.)

At least 22 companies handle some L.P. gases by pipeline. But only two of the piplines undertake any regular, high volume and long distance transportation of specification propane. One is Phillips Pipe Line Co.'s system from Borger to Kankakee, Ill. which has been handling propane since 1947. The other pipeline handling propane regularly, in high volume, over a long distance, is Texas Eastern's Little Big Inch pipeline which was converted to petroleum products in 1958. Future plans and price prospects are discussed.

## 6. GAS AND LPG STORAGE

### Methane

**Methane Drainage in the Afan Valley.** A. R. Myhill. **Part 1.** *Coke and Gas 22*, 62 (1960) Feb. (5 pp.); **Part 2.** *Ibid.*, 210 (1960) May (6 pp.); **Part 3.** *Ibid.*, 254 (1960) June (7 pp.)

Recent methane drainage installation in South Wales is described. Supplies equivalent to about a 1 MMCF of $CH_4$ a week began from Duffryn Rhondda in October 1957 and were augmented in 1958 from Avon and Glyncorrwg collieries. The weekly total is now approaching 7 MMCF at a constant calorific value of 600 Btu/CF. Extraction of gas through boreholes, transmission to the gasworks and safety arrangements provided are discussed and illustrated. Parts 2 and 3 outline

some of the more important items of plant and instruments used in control of firedamp extraction from the collieries and its transmission to the gasworks.

### Methane Liquefaction

**Feasibility of Underground Storage of Liquefied Methane.** D. A. Flanagan and P. B. Crawford. *J. Petrol. Tech. 12,* (Tech. Note 2060) 73 (1960) June (4 pp.)

Study was made of the feasibility of storing liquid methane at low pressures in underground caverns. Methane liquefies at -280°F at atmospheric pressure. It is shown that the methane evaporation rates will rapidly decrease and cool the surrounding rock so that at the end of one month they would be between 50 MCF/hr for a cavern of 25 ft radius and 700 MCF/hr for a cavern of 100 ft radius. At the end of 10 years, the evaporation rates would be 18 and 100 MCF/hr, respectively, for caverns of the same radii. Evaporation rates may be reduced by a factor of 2 to 10 by the application of insulation. Cost for mining the caverns is estimated to be $.75 to $1.25/MCF of storage. This is substantially less than surface storage; it is believed to be safer and to result in lower maintenance, savings in space and savings in strategic materials.

**Housing for Cold Boiling Liquids.** S. Beckwith (assigned to Constock Liquid Methane Corp.) U.S. 2,937,780 (1960) May 24.

In a shipping tank for transporting cold boiling liquids, such as liquefied methane, an improved wall construction is claimed. This comprises a plurality of downward sloping louvres on the inner periphery of the wall spaced vertically to provide a series of overlapping, annular, gas-tight pockets. Into each circumferential louvre pocket a powdered inert insulating material such as silica gel, vermiculite, puffed clay, or glass wool contained in porous cloth bags is wedged in, preferably in two layers separated by a baffle. Gas boiling off collects in the pockets and its pressure prevents cold liquid from entering and touching the tank shell.

**Process for the Vaporization of Liquefied Low-Boiling Gases.** B. Riediger (assigned to Metallgesellschaft A. G.) U.S. 2,937,504 (1960) May 24

Energy is recovered from liquefied low-boiling gases (methane) which comprises vaporizing such gases in a heat exchanger with a gaseous working medium which is thus condensed. The condensed medium (ethane, propane) is raised to a higher pressure, vaporized in a preheater, and expanded in a turbine to recover energy. The vaporized medium may then be recycled to the methane heat exchanger for recondensation. The methane may be used to condense two working media in successive separate stages.

**Sea Transport of Liquid Methane.** L. J. Clark. Paper III A/4. World Power Conference, Sectional Meeting, Madrid. June 1960. (30 pp.)

There are vast resources of natural gas in the waste places of the world which have so far been untapped. If this gas can be transported to the industrial nations in Western Europe or the Far East, a significant contribution could be made to their industrial prosperity. The most promising form of trans-ocean conveyance is to carry the gas as a liquid at a low temperature of minus 162°C and atmospheric pressure in insulated ships, under which conditions its volume is reduced six hundredfold. Possibilities of ocean transport of liquid methane have been put to test in the conversion and operation of the "Methane Pioneer." This large scale test involves the liquefaction and carriage of 2000 tons of liquid natural gas in the converted cargo vessel from Louisiana to the Thames. Seven cargoes were delivered to land storage and regasification equipment and thence it is being used to augment London's gas supply. This project was developed and engineered by Constock International Methane Ltd. in conjunction with the British Gas Council.

**Transportation of Liquefied Gases.** F. A. Howard (assigned to Esso Research and Engineering Co.) U.S. 2,933,902 (1960) April 26.

Improved transport facilities for liquefied natural gas are claimed in which the usual internally insulated liquid methane tanks are supported and immersed in the regular oil tanks of a tank ship, rail or truck tanker, or barge. The oil surrounding the tank serves to dissolve any methane leakage and to eliminate explosive gas mixtures in empty spaces.

### Storage

**Anhydrous Ammonia Storage Tank.** A. Christensen (assigned to Chemical Construction Corp.) U.S. 2,938,360 (1960) May 31

In a low-pressure atmospheric storage tank, as would be used for anhydrous liquid ammonia, with a refrigerating compressor cycle for returning vaporized ammonia to liquid form, a safety pressure-vent is provided. This consists of a vapor vent pipe from tank vapor space, connected to a condenser and spray saturator in which ammonia is chilled and dissolved from the vent gases. These then escape from a lower "breather" pipe if storage pressure is high. If pressure is low, air may enter the breather and saturator system, become saturated with $NH_3$ and pass back to the storage tank.

**Giant Sun Oil Tanker Uses Waste $CO_2$ to Prevent Fire.** *Oil Gas J. 58,* 120 (1960) June 20 (2 pp.)

Like her sister ships in the Sun Oil Co. fleet, the S.S. Eastern Sun is equipped with a $CO_2$ flue gas fire control system. This system has proved itself 100% effective in both Sun Oil refineries and tankships for more than 20 years. Sun Oil Co. developed a six step handling system to produce, prepare and propel flue gas through a marine fire control system. These steps are: generating in main boilers; scrubbing, cleaning and cooling in a bubble-tower type tank; pumping by means of a rotary positive-displacement gas blower; distributing and venting; testing and recording quality and quantity of gas; warning alarm system indicating failures.

**Method and Apparatus for Storage and Transportation of Acetylene.** J. R. Cobb, J. W. Davison and R. E. Sattler (assigned to Phillips Petroleum Co.) U.S. 2,938,359 (1960) May 31

Economic, less hazardous method of storing and transporting acetylene is claimed by solidifying it in barge tanks by heat exchange with liquefied methane. Well-insulated tanks for both liquid methane and solid acetylene are provided, the latter containing a heat exchange coil for liquid methane, which is vaporized while acetylene is pumped into the tank space. The vaporized methane is reliquefied at the loading plant. The methane tank provides refrigeration during transport and also provides a vapor blanket over the solid acetylene. Vaporized material from both tanks may be vented to the fuel-feed line of the barge engines.

### Underground Storage

**"Bubble" Method May Revolutionize Gas Storage.** D. Hale. *Am. Gas J. 187,* 17 (1960) July (2 pp.)

A bubble of natural gas beneath a flat cap rock, surrounded by a wall of water, may be the method of the future for underground storage if a revolutionary experiment underway by Northern Illinois Gas Co. proves successful. Eight water injection wells are drilled in a circle around a gas injection well. Into the wells on the periphery, enough water is injected to form a connecting "wall" of water beneath the cap rock structure. This wall of water will provide a gas-tight seal that will competely enclose the "container" in the middle into which the gas can be injected.

**Is Stored Gas Subject to Law of Capture?** *Oil Gas J. 58,* 86 (1960) June 20

For about a year, Lone Star has been injecting and storing purchased gas in a Bacon line reservoir of East Texas' Tri-Cities field, and an independent operator has been producing gas from a well at the extreme southwest end of the pool. Before court action ends, it may answer an important question: Does an operator who injects gas he bought and paid taxes on retain title to the gas when it goes underground into storage? Or does the gas then again become subject to the law of capture? If the courts decide in favor of the latter, it could deal a heavy blow to the potential of gas storage operations in depleted oil and gas pools in Texas.

**Your Best Bet for Large-Scale Peak Shaving.** G. J. Fenix. *Gas 36,* 57 (1960) July (7 pp.)

Geologic considerations in selecting a suitable site for mined caverns are outlined for the purpose of gas storage for peak shaving demands. Additional storage facilities are necessary because of switch to gas heating. For example, statistics indicate that during a recent nine-year period, total annual sales of a typical large integrated gas company increased 184.5%, while peak-day requirements during the same period jumped approximately 242.8%.

## 7. MANUFACTURED GAS AND CHEMICAL PROCESSING

### Acetylene

**Gas Burner.** F. F. A. Braconier and L. G. Francotay (assigned to Societe Belge de l'Azote et des Produits Chimiques du Marly) U.S. 2,936,829 (1960) May 17.

In a burner used for manufacture of acetylene by hydrocarbon combustion, an improvement is claimed in the design of the gas mixing section. Either fuel gas or oxygen enters an inner annular space formed by an outer water jacket and a central water cooled core. The other gas, either $O_2$ or fuel, enters an outer annulus surrounding the water jacket and the two annuli join below to form a single annular mixing space which feeds a mixing chamber. From the latter the gas passes through multiple burner ports into the ignition zone. Bellows-shaped, corrugated, flexible connections between annular partition and outer walls permit shifting the central core and the annular partition to adjust the gas passages and obtain proper air-gas ratio.

### Ammonia

**Process for the Production of Ammonia Synthesis Gas.** J. F. Grunberg (assigned to L'Air Liquide, Societe Anonyme pour l'Etude et l'Exploitation des Procedes Georges Claude.) U.S. 2,936,593 (1960) May 17.

In a process for producing ammonia synthesis gas by cooling an impure hydrogen and nitrogen stream under pressure, an improvement is claimed by cooling and liquefying the nitrogen stream at a pressure lower than that of the purified hydrogen-rich stream. Liquid nitrogen is compressed at least as high as the hydrogen stream. The hydrogen-rich stream exchanges heat with a divided liquid nitrogen stream, first by hydrogen scrubbing and second by impurity evaporation.

### Aromatics

**Oil May Rob Coal for Naphthalene Market.** *Oil Gas J. 58,* 84 (1960) June 20

By the end of next year producing capacity for napthalene will be increased by 50% as three oil companies begin pouring out the flaky solid at the rate of 225 million lb/year. This newest petrochemical wave broke over coke oven operators and coal tar distillers in three rapid announcements. Ashland Oil & Refining Co. which late last year revealed plans for the first plant, let a contract last week for its new unit at Cetlettsburg, Ky. Sun Oil Co. announced plans to build a 100 million lb plant at Toledo, Ohio. On the following day, Tidewater Oil Co. and Collier Carbon & Chemical Co., an affiliate of Union Oil Co., revealed they will build a 50 million lb plant at the Tidewater's Delaware City, Del., refinery.

## Carbonization

**White Lund: Some Aspects of a New Works.** F. C. Buckley. I.G.E. Communication No. 572; *Gas Times 94*, 46 (1960) June (2 pp.); *Gas World 151*, 929 (1960) June 4 (4 pp.); *Gas J. 112*, 524 (1960) June 22 (5 pp.); **Discussion.** *Gas World 151*, 1074 (1960) June 25 (3 pp.)

White Lund Works of the North Western Gas Board which came into production in April 1958 is the latest and probably the last conventional works to be constructed in this area. The original purpose of the new plant was to replace existing works at Lancaster and at Morecambe. The scheme was widened in scope in its initial stage, to permit closure of five small works in the adjoining district. Circumstances leading to construction of the new works are discussed and some details are given of present loads and future expansion. The site and layout are described and a brief account is given of the construction of the plant.

## Catalysts

**Nitrogen Chemisorption at −195° C on Reduced Iron and Cobalt Oxides.** R. J. Kokes. *J. Am. Chem. Soc. 82*, 3018 (1960) June 20 (4 pp.)

Evidence was presented for chemisorption of nitrogen at −195° C on reduced iron and cobalt oxides. For iron the amount of nitrogen chemisorbed corresponds to 10 to 20% of $V_m$ as determined by the BET method (Brunauer, Emmett and Teller); for cobalt this figure is 50 to 60%. These conclusions imply that nitrogen surface area determinations on metallic catalysts may be subjected to large errors. If allowance is made for such errors it appears that carbon monoxide chemisorption on iron, cobalt and nickel is 1.1 to 1.2 times the correct $V_m$ value.

**The Structure of Cracking Catalysts.** A. Fiumara and G. Salvi. **Part 2.** *Rivista dei Combustibili 14*, 271 (1960) April (20 pp.)

Part 2 of this article deals with the various methods for assaying the two types of acidity and discusses the various tests for measuring surface area, porosity, metallic contaminants and so on. An example is given of how the methods mentioned can be applied in the case of a cracking catalyst which has aged abnormally; analytical investigations made, pin-pointed metallic contamination as the cause of impaired activity.

## Coal Gasification

**New Gasification Process to Be Tested.** *Gas World 151*, 982 (1960) June 11

Economics of a new complete gasification process for obtaining gas from low grade coal are to be investigated at a pilot plant which is to be built at the North Thames Gas Board's works at Bromley, East London. The pilot plant will be operated as an experimental unit by the London Research Station of the Gas Council and its capital cost will be approximately £225,000. It is expected to produce about two MMCF of blue water gas/day. A comprehensive survey of all known methods focused attention on a process known as the slag bath generator which was developed in Germany from an invention by R. Rummel of the Union Kraftstoff A.G.

**Gasification of Powdered Fuel in Pulsating Flow.** D. Y. Gamburg. *Gazovaya Prom. 5*, 12 (1960) May (5 pp. Russian text.)

Theory and development of the resonant tube gasifier are discussed, especially the basic work of Traenkner at Ruhrgas. Pilot plant results for the 4-in. tube by Traenkner are given which showed an intensity of gasification of 1.5 to 2.5 ton coal per sq ft cross section/hour and 2.1 million CF gas per sq ft section/hour. No Russian data are given.

**Westfield High-Pressure Coal Gasification Plant.** T. S. Ricketts. I.G.E. Communication No. 567; *Gas Times 94*, 37 (1960) June (4 pp.); *Gas World 151*, 923 (1960) June 4 (6 pp.); **Discussion.** *Gas Times 94*, 54 (1960) June (2 pp.); *Gas World 151*, 998 (1960) June 11 (3 pp.); *Gas J. 302*, 468 (1960) June 15 (8 pp.)

The author describes the Lurgi plant now nearing completion at Westfield in Fife, and the reasons leading to the introduction of this process on a commercial scale for the first time in Britain. The design of the plant is based on the principle of high pressure gasification of coal. The purification system incorporates a number of unusual features. The purified gas will pass directly into a high pressure grid system at a pressure of 250 psi. Carbon monoxide conversion will be practiced and the carbon monoxide content of the final gas is expected to be below 8%.

## Gasification

**Gaseous Hydrocarbons by Hydrogenation of Coals and Chars.** R. W. Hiteshue, R. B. Anderson and S. Friedman. *Ind. Eng. Chem. 52*, 577 (1960) July (3 pp.); **Producing Natural Gas Substitutes from Petroleum by Continuous Pressure Hydrogenolysis.** E. B. Shultz, Jr., N. Mechales and H. R. Linden. *Ibid.*, 580 (1960) July (4 pp.); **Pipeline Gas by Methanation of Synthesis Gas over Raney Nickel Catalyst.** H. A. Dirksen and H. R. Linden. *Ibid.*, 584 (1960) July (6 pp.); **Pipeline Gas by High-Pressure Fluid-Bed Hydrogasification of Char.** E. J. Pyrcioch and H. R. Linden. *Ibid.*, 590 (1960) July (5 pp.); **Process for Coal Hydrogasification.** C. G. Von Fredersdorff. *Ibid.*, 595 (1960) July (4 pp.)

For abstracts see *Gas Abstracts 15*, 369 (1959) Nov.

**High Btu Gas.** G. C. Williams. *Ind. Eng. Chem. 52*, 575 (1960) July (2 pp.)

Opinions on the present and possible future role of high Btu gas are summarized. Potential sources and probable unit prices are discussed.

## Ethylene

**Process for Recovery of Ethylene.** R. B. Williams (assigned to Dow Chemical Co.) U.S. 2,938,934 (1960) May 31.

A process is claimed for recovering and purifying ethylene from gaseous hydrocarbon mixtures from a cracking reaction. These gases may contain hydrogen, paraffins from methane to above $C_4$, as well as higher olefins and acetylene. By compression and cooling the components of $C_4$ and higher are liquefied and separated, then gases are partly liquefied by further cooling and then demethanized after which residuals are deethanized to leave a mixture of ethane, ethylene and acetylene. After removal of sulfur compounds and $CO_2$, the mixture is hydrogenated to convert acetylene to ethylene and the product is carefully fractionated to recover pure ethylene. Hydrogen is recovered from the demethanizer product by dissolving the methane in ethane.

## Hydrogen

**Process for Chemical Reaction of Fluids.** A. C. Faatz Jr., J. J. Loporto and W. Wong (assigned to Foster Wheeler Corp.) U.S. 2,937,077 (1960) May 17.

Invention relates to the manufacture of hydrogen which comprises passing gaseous hydrocarbons at one pressure and steam at a higher pressure into a jet ejector to obtain intimate mixing at an intermediate pressure; the mixture is heated and passed through a catalytic bed to obtain gas rich in free hydrogen.

**Process for the Production of Para Liquid Hydrogen.** C. R. Class, R. P. Spero and G. E. McIntosh (assigned to Beech Aircraft Corp.) U.S. 2,937,076 (1960) May 17.

For reduction of losses in storage of liquid hydrogen, an improved process is claimed for conversion of the normal 75% content of orthohydrogen into the more stable parahydrogen. The method comprises cooling gaseous hydrogen through two refrigerating heat exchange zones; the second containing a paramagnetic oxide catalyst (iron, chromium, cerium oxides) to obtain partial yield of parahydrogen. The gas is then passed thru a third refrigeration zone, expanded for partial liquefaction and passed partially liquefied through a second oxide catalyst for a complete para conversion. The gaseous hydrogen resulting from the liquefaction of the gas is passed back through at least some of the heat exchange zones to effect the cooling of the incoming gas.

## Hydrogenation

**Underground Hydrogenation.** R. Jenkins (assigned to Socony Mobil Oil Co., Inc.) U.S. 2,937,987 (1960) May 24.

An improvement is claimed in a continuous process for the catalytic hydrocracking of liquid hydrocarbons by the use of an underground cavity (oil well) as a reaction space. The hydrocarbon with hydrogen under pressure, containing suspended catalyst is pumped down a central well tube to the cavity maintained at 800° to 950° F. This inflow reacts exothermally and the product flows out upward through the annular space between tube and well wall exchanging heat to preheat the incoming fluid. Control of reaction is maintained by varying inflow of oil, pressure and temperature.

## Hydrogen Cyanide

**Synthesis of Hydrogen Cyanide from Its Elements and from Ammonia and Carbon.** T. K. Sherwood, E. R. Gilliland and S. W. Ing, Jr. *Ind. Eng. Chem. 52*, 601 (1960) July (4 pp.)

High-temperature chemistry of hydrogen cyanide has become important because of the wide industrial use of this basic chemical, and because of its possible synthesis in high-temperature thermal and arc processes. Data on the synthesis of HCN from its elements were obtained and used to estimate equilibrium constants. Ammonia-nitrogen mixtures are shown to react with carbon to produce a gas containing upward of 10 mole per cent of hydrogen cyanide at 1667°K.

## Low Temperatures

**Low-Temperature Research and Engineering.** K. Mendelssohn. *Chem. & Process Eng. 41*, 233 (1960) June (5 pp.)

Developments in cryogenic engineering are surveyed. Use and management of low temperature physics on an industrial scale is a rapidly expanding field which offers exciting possibilities to both physicist and engineer. The Soviet Union as well as the U.S. have established large government laboratories for the exploration of this new field. Moreover, a very large amount of work on these lines is also undertaken by industrial laboratories in America, many of which have their own helium liquefiers. Although Britain has what is possibly the largest laboratory in the world devoted to fundamental research at low temperatures, its lead is not followed up on the industrial scale.

## Nitrogen

**Methods of Production, Fixation and Use of Nitrogenous Compounds from Engine Exhaust, for Irrigation.** W. L. Morrison (assigned to The Union Stock Yards and Transit Co.) U.S. 2,936,548 (1960) May 17

Production and recovery of nitrogen compounds are claimed for a process in which hydrocarbon fuels are burned with at least 19 parts air in an engine with multiple ignition points to attain high engine temperature (4000°F). Nitrogen compounds formed in combustion are dissolved in irrigation water pumped by an engine, by long contact spray towers of baffled scrubbers. Air Pollution by exhaust gas is reduced and nitrogenous compounds are recovered for irrigation purposes.

## Nitrogen Oxides

**Steam Cuts NO Content of Inert Gases.** T. W. Miller. *Chem. Eng. 67*, 234 (1960) June 13 (2 pp.)

Nitrogen oxide in inert gas leads to nitric acid corrosion. Using steam in the burner cuts flame temperature and decreases NO formation.

## Oil Gas

**Gasification at the Isle of Grain.** C. Stott. I.G.E. Communication No. 568; *Gas Times 94*, 40 (1960) June (2

pp.); *Gas World 151,* 938 (1960) June 4 (5 pp.); **Discussion.** *Gas Times 94,* 55 (1960) June (3 pp.); *Gas World 151,* 1001 (1960) June 11 (3 pp.); *Gas J. 302,* 487 (1960) June 15 (6 pp.)

The author describes the Segas plant, records its performance on different feedstocks, and gives a statement of capital expenditure and the cost of gas manufacture. The paper further deals with considerations that led to the adoption of the high pressure process. It then describes the plant designed to produce a sulfur-free gas with a greatly reduced content of carbon monoxide, and sets out the measures taken to provide the steam and power requirements. Estimates of cost are given in the presentation.

### Olefins

**How to Make and Use $C_4$ Olefins.** L. F. Hatch. **Part 1.** *Petrol. Refiner 39,* 229 (1960) May (4 pp.); **Part 2.** *Ibid.,* 207 (1960) June (4 pp.)

Useful background data on the chemistry, production and utilization of all four isomers of butylene are reviewed. Part 1 covers normal butenes and Part 2 discusses isobutylene.

### Oxygen

**Pressure-Density-Temperature Relationship of Liquid $O_2$.** E. A. Tkachenko. *ARS J. 30,* 566 (1960) June (3 pp.)

Two methods, one based on thermodynamics the other on a generalized equation of state, are employed in conjunction to calculate the pressure-density-temperature relationship of liquid oxygen in the temperature range of 110° to 210°R, and in the pressure range of saturation conditions to 2500 psia. Since no compressibility data for liquid oxygen are available at temperatures higher than 160°R, the results of this investigation should be of special use in rocket engine applications, where the temperature interval 160° to 210°R is of greatest interest. The pressure-density-temperature relationship of liquid oxygen is presented in tabular form, whereas the coefficient of isothermal compressibility is shown graphically, and is compared with previous calculated values.

**Tonnage Oxygen Process.** A. M. Clark. *Chem. & Process Eng. 41,* 243 (1960) June (4 pp.)

Use of large quantities of oxygen for a variety of industrial processes has markedly increased since the war. The important criterion of an oxygen separation plant must be its economy; this is invariably attained by careful use of heat exchange. Hydrocarbon Research Inc. has developed a highly integrated tonnage oxygen process in the U.S.A. which is fully described in this article and an estimate of its production capacity is given. Its particular advantages are discussed in some detail.

### Petrochemicals

**Petrochemical Carbon Disulfide from Methane.** P. W. Sherwood. *World Petroleum 31,* 62 (1960) June (4 pp.)

Carbon disulfide, traditionally produced by the high temperature reaction of sulfur with charcoal, is drawing in rapidly increasing measure on methane and sulfur as its raw materials. This is particularly important in the light of the competitive pressures which plague the carbon disulfide market. In evaluating manufacture of carbon disulfide as a means to upgrade these basic raw materials, market and technological considerations are discussed.

### Reformed Gas

**Recent Developments in the Hasche Process.** R. P. Clarke. *Gas Age 125,* 31 (1960) June 23 (2 pp.)

Peak shaving is facilitated by development of automatic equipment for production of a low specific gravity, high Btu gas from distillates in the gasoline boiling range. Such distillates can be stored cheaply. Therefore, work was begun toward a relatively inexpensive alternation of the automatic controls of the original Hasche reformer to reform light liquid distillates with greater than 80% thermal efficiency to a high-Btu, low-gravity gas of exceptional interchangeability with natural gas. A special feature of this development is the avoidance of concentrations of those heavier constituents in the reformed gas which could condense under conditions of distribution by the utility. A typical analysis is reproduced in the accompanying table.

**Study of Cracking Plants for Liquid and Gaseous Hydrocarbons.** H. Pichler and T. Heike. *Gas- u Wasserfach 101,* 527 (1960) May 27 (7 pp. German text)

This is the third article of a series of publications on the results of tests on cracking plants. The authors report on two plants for production of town gas from LPG. The oven involved here is a vertical chamber retort equipped with cracking pipes (at Wertheim on Main) and an LPG cracking plant with ceramic cracking chamber (at Lichtenfels, upper Franconia). Both plants are described in detail, with photos, diagrams and tables serving as illustrations. As is evident from the indicated test results that the guarantees concerning the performance of the plant and the interchangeability of the gas, offered by the constructor, were fulfilled in the case of the vertical chamber oven plant equipped with cracking pipes; and in the case of the cracking plant with ceramic cracking chamber the results obtained are even more favorable than the guaranteed figures.

### Water

**Making Fresh Water from Salt Water.** *Chem. Eng. 67,* 152 (1960) June 13 (4 pp.)

Recent government decision — that a refrigeration process will be used for demonstration of saline water conversion — spotlights two leading candidates to join desalting processes now in fold. In one process, which Carrier Corp. has been studying in a 15,000 gal/day pilot unit, the saline feed itself provides refrigeration when part of it is flashed at very low pressure. In the other method, a development of Cornell's H. F. Wiegandt and the Blaw-Knox Co., butane refrigerant is

vaporized in direct contact with the feed. Blaw-Knox will start testing this process in a 35,000 gal/day pilot plant around Oct. 1.

## 8. GAS DISTRIBUTION

### Leakage

**Manual vs Mechanical Bar Testing.** L. B. Hulcy. *Gas Age 125,* 19 (1960) June 23 (2 pp.)

Lone Star Gas Co. uses a tractor-mounted bar testing machine and cuts inspection time by 90%, and the cost per hole by 70%; savings in gas purchase costs run nearly 5 times the testing cost.

**New Liquid Seal May End Leaky Joints.** E. O. Hilbush. *Gas 36,* 46 (1960) July (11 pp.)

A liquid sealant called Con-Seal may end once and for all the problem of leaky bell-and-spigot joints in cast iron mains. It permits upgrading low-pressure mains to medium-pressure service so that much larger volumes of gas can be moved through existing systems. A complete report on the experiences of seven companies who have treated almost 500,000 ft of main with Con-Seal are given. In order to appraise the material in its proper perspective, the author reviews the problem and various solutions tried to date.

### Odorization

**Apparatus for Odorizing a Product Without Allowing the Escape of the Odor to the Atmosphere.** E. W. Evans and C. MacSporran. U.S. 2,935,391 (1960) May 3

A method for adding odorizing agent to liquefied petroleum gas is claimed which prevents escape of odor to atmosphere. A pressure vessel is employed into which odorizing agent is emptied, and from there it is forced (by LPG pressure) to a measuring tank, where definite quantities of agent are measured by a sight gage into the gas tank or gas line to be odorized. Venting of the energizing gas to atmospheric pressure is permitted by passing the gas through kerosene which absorbs any odorizing agent.

### Pipe Joints

**Pipe Coupling with Cam Tightening Means.** L. M. C. Seamark. U.S. 2,935,342 (1960) May 3

According to this invention a pipe coupling is formed by split-ring gripping members, mounted on each end of the pipe to be coupled; each member is provided with projecting lugs spaced around the circumference. A cylindrical locking ring engages the respective ends of the gripping members by means of recesses in the inner periphery and each recess is in alignment with each gripper lug. Both pipe ends are inserted into the locking ring and then, by rotating the ring, the wedge-formed engaging surfaces of the lugs and recesses tend to draw the pipes tight and produce intensified radial pressure. Leakage is prevented by rubber sealing rings on the pipe ends.

**Pressure Responsive Fluid Tight Pipe Joint.** G. S. Ellis. U.S. 2,935,343 (1960) May 3

A pressure-type fluid-tight pipe joint is claimed wherein the cooperating component parts are designed to provide a joint which does not impose undue stresses and strains on the tube and end fittings. Briefly summarized, the invention is characterized by an end fitting having a screw-threaded neck and provided with an axial recess. The tubing is welded into a larger adapter socket which fits snugly into the end fitting and is formed with a shoulder at upper periphery. This shoulder retains an O-ring seal which is held in the recessed enlargement of the fitting. A split wire ring is seated into a groove above the beveled shoulder to retain the latter against outward movement and leakage.

## 9. GAS FUEL UTILIZATION AND APPLIANCES

### Air Pollution

**Industrial Ovens Designed for Air Pollution Control.** P. H. Goodell. *J. Air Pollution Control Assoc. 10,* 234 (1960) June (5 pp.)

Sources of oven hazards and ovens contributing to air pollution are outlined. Five basic methods for applying catalysts to ovens are recommended to meet the objectives described. Selection will depend upon design and operating temperature of the oven heating system, available space, method of control desired and cost considerations. All of the systems were field proved with results demonstrated to the satisfaction of interested air pollution control authorities. Cost considerations are substantially improved by incorporating the air pollution control system as an integral part of the initial oven design.

**Modifications to Reduce Emissions from a Flue-Fed Incinerator.** E. R. Kaiser, J. Halitsky, M. B. Jacobs and L. C. McCabe. *J. Air Pollution Control Assoc. 10,* 183 (1960) June (16 pp.)

New York University has conducted a program with the primary objective to develop and evaluate by field tests various modifications to existing incinerator installations that will reduce the emissions of particulate matter, noxious gases, smoke, and odor to the atmosphere. A secondary objective was to obtain data and experience to guide the selection of incinerator features for new installations. The program included 38 tests on three flue-fed, single-chamber, refuse incinerators in three 16-story apartment buildings to determine the amount of atmospheric pollution from the incinerator flues and the effectiveness of several appliances in reducing the emission of atmospheric contaminants from such incinerators. Appliances tested were: Overfire air jets, luminous-flame gas burner with overfire air jets, the Hartmann device with secondary combustion chamber, Peabody gas scrubber. The Werner principle for rapid combustion was tested and locking of the service hoppers in the flue was practiced on the tests to simulate the effect of automatic hopper locks.

## Burners

**High Pressure Gas Burners.** W. Ferguson (assigned to National Airoil Burner Co.) U.S. 2,935,128 (1960) May 3

High pressure gas burner for industrial firing is claimed which provides two inspirating burner tubes. The first fires centrally into the furnace burner block through radial ports, while the second is firing concentrically around the first through annular ports. This provides a controlled flame pattern of hollow conical shape of lower gas velocity for more uniform furnace heating.

**The Hypact Burner.** J. C. Salmon and F. C. Forder. *Gas J. 302,* (Gas in Ind. Sect.) 160 (1960) June 1 (7 pp.)

Hypact burner provides a means of burning gas in a relatively small flame by means of a simple and cheap design of burner head that can operate under all normal pressure conditions of gas supply and forced draughts. Premixing of the gas and air is not necessary. The first experimental range of sizes was made from mild steel sheet. These experimental burners were fabricated in such a way that the inner surfaces of the flat flame jet were reproduced but with linear magnification and since the walls were of thin metal sheet they illustrate the general design of the "industrial" jets.

**Literature Review of Infra-Red Energy Produced With Gas Burners.** D. W. DeWerth. Research Bulletin 83. Project IA-14. (New York: American Gas Association, 1960, $2.00.)

Evaluation of the available literature pertaining to infrared energy production by both gas and competitive means is presented. Gas-fired infrared burners are described and evaluated, and compared to infrared energy generated by competitive means. The literature search has indicated that the use of gas fired infrared burners should become a field of ever increasing gas usage. Many current applications of infrared are described and an extensive list of possible future applications is presented. Necessity for future research is indicated.

**New Studies of Porous Medium Burners.** W. R. Staats, E. A. Roth and R. T. Ellington. *Am. Gas. J. 187,* 23 (1960) July (4 pp.)

Porous-diaphragm burner consists of a porous matrix, usually of refractory material, fed with a near-stoichiometric gas-oxidant mixture. In proper operation, the combustion wave is stabilized on the downstream face of the matrix. Under certain conditions, however, the combustion wave may retreat from the surface, and if it passes through the matrix, cause a dangerous flashback in the mixture line. This study was conducted with the hope of helping the gas industry in the design of these burners for proper operation and effective use.

## Combustion

**Carbon Black from Flames or Oxidants in Hydrocarbons.** C. B. Bachman and H. I. Berman. *Ind. Eng. Chem. 52,* 621 (1960) July (4 pp.)

Hydrocarbon combustion studies were conducted in the hope of finding chemical evidence for carbon-containing radicals postulated in intermediates in flames and of utilizing these radicals in flame syntheses. Burning oxidants in hydrocarbon atmospheres gave increased amounts of carbon rather than volatile organic compounds. With chlorine as oxidant the carbon was found to contain substantial amounts of chemically bonded chlorine. Chlorocarbon blacks obtained in this way differ in composition and probably basic structure from ordinary blacks. They offer interesting possibilities of application in the fields of plastics and rubbers. Carbon blacks modified with other elements were also obtained by this process.

## Flame Research

**Burning Rates and Ignition Temperatures of Hydrogen Peroxide Solutions.** C. N. Satterfield, E. Kehat and M. A. T. Mendes. *Combustion and Flame 4,* 99 (1960) June (7 pp.)

Hydrogen peroxide decomposition flame above concentrated liquid solutions was studied at atmospheric pressure. Mass burning rates were found to agree closely with the flame velocities as measured for the vapor by the bunsen burner method, when compared at equal adiabatic decomposition temperatures. Limiting combinations of solution concentration and temperature for ignition of flames above hydrogen peroxide solutions are reported to help establish the regions of hazard in handling this material.

**Passage of Explosions Through Narrow Cylindrical Channels.** H. G. Wolfhard and A. E. Bruszak. *Combustion and Flame 4,* 149 (1960) June (11 pp.)

Transmission of explosion through narrow channels is investigated. The channels connect two explosion chambers. Ignition in the outer chamber following firing of an explosive mixture in the inner chamber depends on the geometry of the channel. It was found that a propagating methane-air flame does not travel through channels of less than about 3 mm diameter, although ignition may still occur in the outer chamber. Hot burned gases from the inner chamber issue into the outer chamber and may lead to ignition which originates in the hot eddies of the turbulent jet. Ignition or non-ignition depends mainly on the gas dynamic properties of the jet, which in turn depend on the channel geometry. Schlieren pictures of the outside ignition process also confirm the proposed mechanism.

**Studies of Combustion Processes Leading to Ignition in Hydrocarbons.** K. C. Salooja. *Combustion and Flame 4,* 117 (1960) June (20 pp.)

Extents of overall reaction at various temperatures preceding ignition and also the ignition temperature/concomitant lag relationships of $C_6$-$C_9$ hydrocarbons were studied in a quartz reaction chamber at atmospheric pressure. The hydrocarbons studied include n-heptane, methylcyclohexane, iso-octane, di-iso-butylene, benzene, toluene, m-xylene and ethylbenzene. Marked differences exist between hydrocarbons with regard to their

extents of pre-flame reactions and ignition characteristics, and also with regard to the effect of fuel-air composition on these properties.

**Theoretical Calculations in Gaseous Detonation.** C. L. Eisen, R. A. Gross and T. J. Rivlin. *Combustion and Flame 4,* 137 (1960) June (11 pp.)

Extensive Chapman-Jouguet, strong and weak detonation properties were obtained for a five atom (C, H, O, N, A) system. A digital computer program was developed which determines detonation properties in steady one-dimensional equilibrium flow. Equations and method of solution are presented. Equilibrium and frozen sound speeds are calculated for the hot product mixtures. The effect of initial conditions and comparisons with experiment are given.

**The Theory of a Spherical Premixed Laminar Flame.** A. A. Westenberg and S. Favin. *Combustion and Flame 4,* 161 (1960) June (11 pp.)

General equations governing the behavior of a low velocity, steady state, premixed, laminar flame are given for the case of spherical symmetry and the differences from the plane flame pointed out. Numerical solutions obtained on the computer for a simple flame with Lewis number unity are discussed. Definition of burning velocity is discussed, and its dependence on radius of curvature is clearly shown by the results. The relation between flameholder heat loss and stability is examined in the light of a recent discovery by Hirschfelder and co-workers. Advantages of the spherical flame for flame structure studies are described.

### Heat Transfer

**Heat Transfer.** R. F. Hayman. *Gas World 151,* (Ind. and Comm. Gas Sect.) 106 (1960) June 18 (4 pp.)

Examples of the ways in which thermal performance of appliances can be improved are discussed and some future possibilities in the extended use of nonluminous flames and in applying the technique of forced convection at high gas velocities are pointed out. Little data are available on the mechanism of forced convection heat transfer from gases at high velocities and high temperatures and the author considers that this should be the subject of full scale fundamental studies.

### Heat Treating

**Largest Forge Shop Has 87 Furnaces for Forging and Heat Treating Operations.** *Ind. Heating 27,* 1182 (1960) June (4 pp.)

World's largest producer of forgings is the Kropp Forge Co. in Cicero, Ill. which is one of the major sources of quality forgings in America. In order to heat the forging stock, there are 68 gas-fired forge furnaces and 19 gas-fired heat treating furnaces. Some idea of the extent of the heating operations may be realized from the average annual gas consumption of almost one billion CF.

**Mass Production Heat Treating Line Maintains Close Quality Control.** J. R. Blake. *Ind. Heating 27,* 1168 (1960) June (8 pp.)

Six new Holcroft continuous furnaces are now in production to process cap screws, wrenches and other products. Each line consists of an automatically loaded, radiant tube heated, controlled atmosphere hardening furnace, quench tank wash machine, tempering furnace and dip tank. The hardening furnaces are heated by gas fired, sealed head, return bend radiant tubes that give efficient even combustion at all firing rates. These units contain a closely controlled endothermic atmosphere that can be varied to produce a carbon potential that is in equilibrium with the steel parts being processed.

**How Stanley Products Assure Their Quality With Gas as a Fuel.** A. Q. Smith. *Ind. Gas 38,* (American) 2 (1960) June (3 pp.)

Strip steel at the cold rolling mills is bright annealed in gas-fired 30 ton, bell type, furnaces in a DX atmosphere in the temperature range of 1200° to 1800°F. Other uses of gas at the Stanley Works are normalizing of special strip, borderizing of strapping, lithographing of seals, and steam generation.

### LPG

**Big Push in Flame Cultivation.** W. W. Clark *Butane-Propane News 22,* 29 (1960) July (6 pp.)

An emergency weeding job in the cotton fields of the High Plains Research Foundation near Plainview, Texas, necessitated a quick, inexpensive method. The performance of propane-fired flaming equipment so impressed the researchers that a full scale research program was started. When this study is completed it is hoped to prove the applicability of flame cultivation to dozens of crops, including vegetables, grown throughout the U.S.

### Refrigerators

**Whirlpool Simplifies Gas Refrigerator.** *Appliance Manufacturer 8,* 61 (1960) June (3 pp.)

Whirlpool Corp. has completely re-engineered three gas refrigerator models. Objectives of this new program were: weight reduction, simplified cooling unit, increased interior dimensions, a fan-cooled absorber, two-door unit, air blast cooling technique for refrigerator and freezer compartments, and automatic defrosting freezer.

### Water Heaters

**Design and Performance Characteristics of High Recovery Gas Storage Water Heaters.** J. W. Gergel and J. C. Griffiths. Research Report No. 1311. Project DA-2-WH. (New York: American Gas Association, 1960, $1.00.)

An experimental 30 gal table-top water heater was designed and constructed to operate at a heat input rate of 40,000 BTU/hour with a 4-in. diameter flue outlet, or at 36,800 BTU/hour with a 3-in. flue outlet. With these input ratings the normal recovery capacities of this heater were 33.6 and 30.9 gal of water/hour heated through a temperature rise of 100°F. Results of a three year study with two identical models of an experimental 60,000 BTU/hour 30 gal storage water heater design indicate that corrosion of the storage

tank with such a high heat input and recovery is not any greater than that for a contemporary unit of comparable size with a heat input of 30,000 BTU/hour.

**Flame Characteristics of Gas Storage Water Heater Burners.** J. W. Gergel and J. C. Griffiths. Research Bulletin 82. Project DA-2-WH. (New York: American Gas Association, 1960, $2.00.)

Performance trends, determined for various types of contemporary burners and flue type water heater tanks, indicated greater burner flexibility with regard to lifting and yellow tipping of flames in the combustion chamber than under open room conditions. Thus, burners designed for a reasonable degree of flexibility from previously published lifting and yellow tipping information obtained under open room conditions may be expected to operate reasonably well in the combustion chamber. However, the combustion chamber environment may promote such conditions as flashback at extinction and "floating" flames. These characteristics may tend to limit the flexibility of a burner in the combustion chamber.

## 10. EQUIPMENT AND INSTRUMENTATION

### Fluid Flow

**Mass Flow Measurement.** R. Siev. *Instruments and Control System 33,* 966 (1960) June (5 pp.)

Demand for mass flow measuring devices has resulted in refinement and improvement of compensation practices and in the development of new mass flow measurement principles and devices. Axial flow, radial flow, gyroscopic, vortex velocity and thermal devices are available to measure mass flow of fluids and their principle of operation is discussed.

**For Process Design: Flow of Fluids.** E. E. Ludwig. *Chem. Eng. 67,* 162 (1960) June 13 (48 pp.)

Process design for conduits of flow—more specifically, circular pipe, tubing and fittings—are covered. Problems of intra-plant transport are emphasized. Pumping liquids in process lines are discussed. Proper selection of pumps, particularly by centrifugals, to meet process performance requirements is discussed. Correlations for Newtonian systems are only considered here; although considerable data exist for non-Newtonian fluids, physical and rheological properties limit application.

### Fractionation

**Latest Advances in Superfractionation.** F. W. Winn. *Petrol. Refiner 39,* 139 (1960) June (7 pp.)

A superfractionator is defined here as one involving 30 or more theoretical stages at total reflux. The relative volatility is generally below 1.5 and the purity of one or more products may be better than 99%. A difference of 10 to 20% from the optimum in reflux or number of trays can involve thousands of dollars in investment and annual operating costs. An exact calculation procedure is needed in order to provide an accurate relation between the number of trays and reflux rate. A procedure is given which represents a new approach to solving distillation problems accurately for cases where the relative volatility does vary from top to bottom trays. It is applicable over sections of each column where the L/V ratio is constant. Fortunately, most superfractionators have a constant L/V ratio for all trays in both the rectifying and stripping sections.

### Furnaces

**Thermal Property Measurements at Very High Temperatures.** N. S. Rasor and J. D. McClelland. *Rev. Sci. Instruments 31,* 595 (1960) June (10 pp.)

Techniques and apparatus were developed for determination of thermal expansion, specific heat, and thermal conductivity to as high as 3650° C. To obtain and measure the temperatures required, a graphite tube furnace, a graphite helix furnace, and a photoelectric pyrometer were developed and constructed. The details of their design and their use for property determination to the destruction temperatures of a variety of refractory materials are described.

### Heat Exchangers

**Dynamics of Heat Exchangers and Their Models.** H. Thal-Larsen. *J. Basic Eng. 82,* 489 (1960) June (16 pp.)

The author rejects, momentarily, actual experimentation with real heat exchangers for logical cogitation. Observed as mental images or models, these heat exchangers reveal their basic characteristics—characteristics that will be partially obscured in an actual experiment by secondary effects inherent in the equipment. These characteristics may be used to correlate by means of frequency-response diagrams many results heretofore diverse and seemingly unrelated, that have been reported in the literature. Included among such results are not only the dynamics of various types of heat exchangers but also the thermal dynamic interaction between fluids and the confining pipe used for their transport. In addition, the author warns that all too frequently the use of average temperature in heat exchanger dynamics is based on faulty logic.

### Metering

**Testing Small Orifices.** J. M. Benson and C. E. Hawk. *Instruments and Control Systems 33,* 996 (1960) June (3 pp.)

Small orifices and nozzles of the types used in gas burners, oil burners, spray guns and expansion throttles of refrigeration machines are manufactured to tolerances that may be difficult to hold in routine production unless sample units are regularly inspected for accuracy of the drilled holes. The most satisfactory method of inspecting these orifices is to establish a flow through the hole under a given set of conditions that are accurately known, and to measure the resulting flow. The method described here makes use of a sensitive flowmeter comprising a compensated thermopile

to measure the critical flow of air through the nozzle. The method and equipment have proven well adapted to the measurement of orifices having diameters ranging from 0.002" to 0.010", but are not limited to that range.

## Pilot Plants

**What About Pilot Plant Instrumentation.** R. J. Fanning and J. D. Bryan. *Control Eng. 7,* 85 (1960) July (3 pp.)

Considerable emphasis is now being placed on instrumenting and controlling pilot units to yield accurate, useful information in minimum running time; pilot plants are operated today within the control spectrum that extends from basic analog control to digital computer control. The authors survey the present state of art and the special considerations involved in applying control techniques to pilot plants.

## Pumps

**Considerations in the Application of Pumps in Chemical Plants.** R. E. Gillmor. *Ind. Eng. Chem. 52,* 566 (1960) July (3 pp.)

Pumping chemical fluids presents problems in pump selections originating from the multiplicity of physical properties of these liquids. A complete investigation of these properties as well as the system requirements and the environment effects will disclose considerations which must be met by the selection of proper pump characteristics. A tabulation of the resulting data provides a complete basis for stating pump requirements.

**Design Factors Affecting Selection of Pumps for Chemical Service.** E. G. Hoffman and D. M. Calkins. *Ind. Eng. Chem. 52,* 561 (1960) July (5 pp.)

Chemical pumps, because of their simplicity and common usage, are often selected without due consideration of the design factors worthy of their importance. The design factors mentioned are based on actual experience associated with chemical and mechanical designers who are required to select chemical pumps for process operations in the pharmaceutical business. Corrective measures to alleviate existing difficulties, correct faults of present designs and aim for greater efficiency on future design selections are pointed out.

**Pump Theory.** E. J. Serven and R. R. Rhodes. *Ind. Eng. Chem. 52,* 557 (1960) July (4 pp.)

Standard system of classification is used to review the operating theory of the most common pumping equipment found in chemical service. Pumps are classified as either kinetic or positive displacement. Kinetic pumps are broken down to centrifugal and regenerative types for discussion. In the positive displacement category both rotary and reciprocating pumps are presented. Pumps requiring further classification are discussed only insofar as it is necessary to define their operating theory, which provides the background required for individual design features and the areas of application for each type.

## Temperature Measurement

**Analog Network to Convert Surface Temperature to Heat Flux.** G. T. Skinner. *ARS J. 30,* 569 (1960) June (2 pp.)

A simple analog network was devised, for use with thin film resistance thermometers, which carries out the mathematical operation of transforming surface temperature into heat flux. The method is applicable to shock tube and shock tunnel work. A calibration unit completes the system which eliminates the necessity for complicated computational procedures.

**Interpolation of Platinum Resistance Thermometers, 20° to 273.15° K.** R. J. Corruccini. *Rev. Sci. Instruments 31,* 637 (1960) June (4 pp.)

A numerical method for interpolating the resistance temperature relation of a platinum resistance thermometer is given. Calibration at three points such as 20°, 90°, and 273° K is required. The interpolation is then carried out by reference to the complete resistance temperature relations of two other slightly different thermometers. Limited tests suggest that it is possible to achieve a temperature scale in this way using commercially available thermometers that are reproducible within 0.001°, provided the Callendar-van Dusen constants and the residual resistance ratio are sufficiently restricted.

**Method of Butt Welding Small Thermocouples 0.001 to 0.010 Inch in Diameter.** C. M. Stover. *Rev. Sci. Instruments 31,* 605 (1960) June (4 pp.)

A method of butt welding thermocouples 0.001 to 0.010 in. in diameter is described. The thermocouple wires are positioned in a micro-manipulator, and a controlled welding pulse is applied to them. This welding method provides uniform upset welds through a simple production technique.

**Modern Trends in Resistance Thermometry.** P. H. Stirling and H. Ho. *Ind. Eng. Chem. 52,* 59A (1960) July (3 pp.)

Modern metallurgical techniques and products have increased service life of thermocouples. There is a trend toward more complex control systems using online process control computers or derived displays for accurate quality control. Greater reliability promised by solid state switching devices with no moving mechanical parts has inspired many development programs in this field and the resistance thermometer is preferred because of its high output. Resistance thermometers will not displace thermocouples completely or vice versa. Both have their place but the emphasis is changing and the low cost of present day miniature platinum resistance bulbs of fast response usable up to 1100° C will speed their wider application.

**Welded Thermocouple Junctions.** H. C. Jordan. *Instruments and Control Systems 33,* 988 (1960) June (3 pp.)

Welded thermocouple junctions have many advantages, but diverse test and instrumentation needs may call for different thermocouple configurations. Not only must the correct wire size and material combination be selected, along with proper insulation, but also the method of joining the wires (butt, cross-wire, coil-type

sandwich) and welding technique. Design charts given classify some of the useful data derived from hundreds of practical thermocouple installations. Data is included for Iron/Constantan, Chromel/Alumel, Copper/Constantan and Platinum—10% Rhodium/Platinum.

### Valves

**Valves for Severe Corrosive Service.** E. G. Holmberg. *Chem. Eng. 67,* 146 (1960) June 27 (3 pp.)

These proved valve designs were developed after much trial and error and are ideally suited for severe corrosive service. The author presents the latest thinking on the following valves: gate, globe and needle valves, long bonnet gate valve, jacketed valves, V-port globe, Y-globe, and diaphragm valves.

## 11. MATERIALS OF CONSTRUCTION, AND CORROSION

### Cathodic Protection

**Cathodic Protection of Prestressed Concrete Pipe.** M. Unz. *Corrosion 16,* 123 (1960) June (9 pp.)

Prestressed concrete pipe has the reinforcement either partly embedded in the concrete core or totally placed over the core under a cement mortar cover. Lines of the latter type are bonded at the steel joint rings to provide for electrical continuity. With the aid of insulating joints at junction points, adequate control of galvanic currents is ensured. The lines also have the advantage of being suitable for cathodic protection. From an analysis of the line constants it follows that higher drainage current densities are required for this kind of pipe than in bituminous coated systems. Feeding points must be spaced closer due to stronger attenuation. Nevertheless cathodic protection can be economically applied under corrosive conditions. A field example and constructional details are given; design methods are numerically discussed.

**Effects of Electrical Grounding Systems on Corrosion.** B. Husock. *Pipeline News 32,* 48 (1960) June (5 pp.)

In providing cathodic protection for an underground structure which is connected to a copper grounding system, it is often necessary to use considerably more current than in providing protection for isolated underground structures. While it would be best to isolate the underground structure from the copper grounding system, in many instances this is either not desirable or not practical. Thus, in designing a cathodic protection system for a given structure, it is often necessary to provide sufficient current not only to overcome the normal corrosion activity on that structure, but to overcome the potential between the structure and the electrical ground.

### Coatings

**Coating Yard Features Automatic Operation.** L. F. Bramble. *Pipeline Eng. 32,* D-33 (1960) June (2 pp.)

Production line techniques and near full automatic operations are used to speed cleaning and coating of pipe in a new yard of S. E. Culbertson Co., Houston, Texas. Reduced labor costs and rigid quality control are major benefits. The plant is equipped to coat and wrap pipe from 4 to 36 in. diameter, to straighten and recondition older pipe, to pickle and clean pipe chemically, and to perform other special operations.

**Duties of a Coating Inspector.** J. B. Vrable. *Gas Age 125,* 36 (1960) June 9 (2 pp.)

Duties and extent of authority of the coating inspector are described. Mistakes made during coating application can have far reaching effects and influence protection requirements for the life of the pipeline.

**What's Happening to Hot-Applied Coatings?** N. T. Shideler. *Oil Gas J. 58,* 104 (1960) June 13 (5 pp.)

Tonnage of hot-applied coatings used on pipelines in 1959 was only slightly less than 350,000 tons/year used in the peak years of 1952 and 1953. Reports from the major mill applicators indicate that their tonnage of hot-applied coatings used and footage of pipe coated in 1959 was up about 25% over that of 1957 and 1958. The trends indicate that hot applied coatings will continue to be the main line of defense against corrosion of underground pipelines for at least 10 years or possibly longer. The author presents a table of favorable and unfavorable performance characteristics of coating systems as well as an evaluation of new and old coatings.

**Relation of Molecular Structure and Pigments to Coating Performance.** *Corrosion 16,* 32 (1960) June (4 pp.) (Revision of paper by H. F. Payne)

Main components of coatings, with emphasis on their characteristics related to these components, are discussed. Molecular structure, significance and function of primary and secondary bonds, relationship of molecular weight to performance are considered. Function of modifiers and how they influence the characteristics of coating is explained. Mechanism of adhesion is reviewed briefly, considering the fundamental mechanical and electrochemical factors involved in this phenomenon.

### Corrosion

**Effect of pH on Oxygen Corrosion at Elevated Pressures.** O. L. Riggs, Jr., J. D. Sudbury and M. Hutchison. *Corrosion 16,* 94 (1960) June (5 pp.)

Oxygen corrosion of mild steel in brine was studied. Corrosion rates were determined for oxygen pressures ranging from atmospheric to 515 psia and over a pH range of 1 to 13.5. All tests were conducted at room temperature. It is shown that corrosion rates are generally increased with increasing oxygen pressure and decreasing pH; however, when tests exceeded 6 hours duration, an accelerated corrosion developed over the pH range 8 to 12. An unusual filamentary type corrosion product develops and grows in the 300 to 500 psi oxygen pressure range in pH 12 system. Identification and proposed mechanism of growth are given.

**Effects of Alternating Currents in Causing Corrosion.** F. E. Kulman. *Gas Age 125,* 32 (1960) June 9 (3 pp.)

In reviewing the studies to date on a-c electrolysis corrosion, author concludes that none of them include every factor involved and additional research has to be made before the conditions under which a-c electrolysis will occur can be prevented or predicted on buried structures.

### Inhibitors

**Sodium Chromate Inhibitor in an Ethylene Glycol Engine Coolant.** L. C. Rowe. *Corrosion 16,* 93 (1960) June

Laboratory tests were made to determine the suitability of sodium chromate inhibitor for ethylene glycol engine coolant. In presence of light, chromate solutions turned green and dichromate solutions formed greenish precipitates. In absence of light, little color change was noted. Following completion of laboratory testing, eight-month long tests were made in automobile cooling systems. Methyl alcohol and ethylene glycol antifreezes were tested separately after addition of chromate. Indications were that chromate inhibitors could be used with ethylene glycol in the absence of light in cases where a laboratory evaluation of operational factors was made.

### Insulation

**Unique Insulation Cuts Equipment and Fuel Costs 80%.** *Ind. Gas 38,* (Amer.) 6 (1960) June (2 pp.)

By using a unique cellular silica material to insulate a new atmospheric brazing furnace, Pacific Scientific Co., was able to save 80% of the estimated heating costs. Key to the furnace's performance is a lightweight refractory, Foamsil, a product of the Pittsburgh Corning Corp. The material is 99% pure fused silica glass foamed in a special very high temperature furnace to create millions of tiny sealed cells. The material can cycle from –450°F to +2000°F without thermal shocking. It weighs only 13 lb/CF, yet has a compressive strength of 200 psi. However, the key factor is the material's low specific heat (only .277 at 1200°F) combined with light weight.

### Welding

**New $CO_2$ Gas Shielded Welding Saves Time, Money in Joining Pipe.** *Heating, Piping & Air Conditioning 32,* 136 (1960) June (3 pp.)

A new $CO_2$ gas shielded welding process was developed which uses gas at a greatly reduced cost. The $CO_2$ performs the same function as argon and helium in the "stick" welding process. In place of the manual electrode, a micro-wire electrode with a diameter of 0.020 to 0.045 in. is used. The arc voltage employed is 16 to 20 volts and the current is in the range of only 50 to 150 amperes d-c, reversed polarity. At its present stage of development, this process is recommended only for P-1 carbon steel piping.

## 12. ANALYTICAL METHODS AND TESTS

### Analytical Instruments

**Portable Instruments Analyze Workroom Atmospheres.** J. Zatek. *Ind. Eng. Chem. 52,* 73A (1960) July (2 pp.)

In view of the growing awareness of industrial contaminants as a health hazard, the question of methods for accurately measuring low concentrations of potentially harmful gases and vapors arises. A number of commercially available instruments were developed for specific analysis of industrial atmospheres. Instruments used for collecting or measuring these concentrations are classified by their function. There are those which will collect a sample for subsequent microscopic, physical or chemical analysis and those which will permit immediate indication of the amount of the specific contaminant for which they were designed.

### Chromatography

**Analytical Distillation by Gas Chromatography. Programmed Temperature Operation.** F. T. Eggertsen, S. Groennings and J. J. Holst. *Anal. Chem. 32,* 904 (1960) July (6 pp.)

A new simple technique of gas chromatography with programmed temperature operation makes wide range, single-staged analyses of hydrocarbon samples. The effluent hydrocarbons are oxidized to carbon dioxide and measured by thermal conductivity. Only a few milligrams of sample are required and the method yields in ½ hour the information obtained by 20 plate conventional distillation.

**Chromatography Works Fast in Showing Up Differences in Crudes.** J. C. Winters. *Oil Gas J. 58,* 138 (1960) June 13 (2 pp.)

Procedure for separating light naphtha from crude, separating the naptha components, and measuring separated components by chromatography is described.

### Dust

**Aerosol Filtration with Membrane Filters for Particles Below 0.1 Microns.** W. Walkenhorst. *Staub 19,* 69 (1959) March (4 pp. German text.); (From *Appl. Mech. Rev. 13,* 452 (1960) June)

Tests are carried out to establish the filter capability of membrane filters, for which a fine particle aerosol with particle sizes up to about 0.1$\mu$ was used. The test arrangement including the aerosol source used is described. The results obtained are quoted. With 0.1$\mu$ particle size the filter capability is nearly 100%, growing somewhat less with decreasing particle size. But with particle sizes of 0.01$\mu$ and the filter for the coarse permeability stage, the filter capability still comes to about 94%, and the filter for the middle permeability stage to 97%.

**Comparative Measurements with Different Dust Measurement Procedures.** E. Effenberger. *Staub 19,* 44 (1959) Feb. (3 pp. German text.); (From *Appl. Mech. Rev. 13,* 452 (1960) June)

Over a period of 12 months it was possible to carry out comparative measurements with the Diem adhesion foil method, the Lobner dust collection apparatus and the Effenberger registering appliance. Between the results given by the registering method and those given by the adhesion foil method there exists a statistically secured connection, if the average of the measuring results of at least five adhesion foils is taken as a basis. It was not possible to establish any statistically secured connections between the results obtained from the collection apparatus and the adhesion foils on the one hand and the collection apparatus and the registering appliance on the other hand.

**Investigations on the Comparability of Various Dust Measurement Methods.** W. L. Hartmann. *Staub 19,* 345 (1959) Oct. (7 pp. German text); (From *Appl. Mech. Rev. 13,* 453 (1960) June)

Results of various dust measuring methods were compared. The investigations proved that there exists a good degree of correlation between the results of the various methods in the case of dusts with a small portion of agglomerations. With dusts having a large share of agglomerations, it is necessary to determine the conversion factors between the measuring methods in each case and they apply only for the dust condition concerned.

**Measurement of Dust.** J. Olaf. *Staub 19,* 221 (1959) June (6 pp. German text); (From *Appl. Mech. Rev. 13,* 452 (1960) June)

Article provides a survey of the dust measuring processes and methods mentioned in the literature, special consideration being given to problems arising in the coal mining industry. Special care was taken to include those measuring instruments, appliances and processes which are as yet little known.

**A New Method for the Measurement of Dust.** A. Winkel. *Staub 19,* 253 (1959) July (3 pp. German text); (From *Appl. Mech. Rev. 13,* 453 (1960) June)

A new dust measuring method with soluble Microsorban filters is reported. Compared with customary methods, this measuring method has an advantage inasmuch as it permits the precipitation of large quantities of dust without any material pressure rise on the filters and makes them easily accessible for an analysis.

### Emission Spectrography

**Spectrographic Analysis of High Purity Nickel.** R. L. Rupp, G. L. Klecak and G. H. Morrison. *Anal. Chem. 32,* 931 (1960) July (3 pp.)

Impurities in high purity nickel samples are determined by a direct spectrographic procedure. Sensitivity is increased by performing the arcing in argon or nitrogen atmospheres. The method is applicable to many elements in the concentration range of 0.1 to 100 ppm.

### Hydrocarbons

**Continuous Trace Hydrocarbon Analysis by Flame Ionization.** A. J. Andreatch and R. Feinland. *Anal. Chem. 32,* 1021 (1960) July (4 pp.)

Continuous quantitative estimation of trace amounts of hydrocarbons are obtained by using a specially designed portable flame ionization detector. It responds in proportion to the number of carbon atoms in the hydrocarbon. It is applicable as an automotive exhaust analyzer, determining unburned hydrocarbons and such units as methane, ethane, ethylene and others.

### Hydrogen Sulfide

**Detection of Hydrogen Sulphide in High-Pressure Gas Wells.** F. G. Rowe, A. W. Bartunek, R. L. McGlasson, F. H. Meyer and R. A. Royer. *Chem. & Ind.,* 712 (1960) June 18 (2 pp.)

Copper coupons, 8 in. by 1 in. by ⅛ in., were polished on a metallographic polishing wheel and then etched lightly in nitric acid to produce surfaces suitable for electron diffraction. These coupons were sent to gas fields and suspended in various wells for 15-30 days. Copper, having high affinity for sulfide, would act as a collector of $H_2S$, if present in the gas well. After exposure to the gas stream, the coupons had tarnish or corrosion scales of varying thickness, but in all cases less than one mil. The corrosion scales were identified by electron and x-ray diffraction methods as cuprous sulfide; hence, the presence of trace quantities of $H_2S$ in sweet gas wells was established.

**Simultaneous Determination of Hydrogen Sulfide and Mercaptans by Potentiometric Titration.** M. W. Tamele, L. B. Ryland and R. N. McCoy. *Anal. Chem. 32,* 1007 (1960) July (5 pp.)

Hydrogen sulfide and mercaptans in mixtures are simultaneously determined by potentiometric titrations. Aqueous samples are titrated in 1N aqueous sodium hydroxide with sodium nitrate. Nonaqueous samples are titrated in alcoholic sodium acetate electrolyte. Iodide, bromine and cyanide interfere.

### Methane

**Infrared Absorption Spectrum of Methane from 2470 to 3200 cm$^{-1}$.** E. K. Plyler, E. D. Tidwell and L. R. Blaine. *J. Res. Nat. Bur. Stand. 64A,* 201 (1960) May-June (12 pp.)

Absorption spectrum of methane was measured from 2470 to 3200 cm$^{-1}$ with a high resolution infrared spectrometer. Pressures from 0.01 to 4.5 cm of the gas were used in order to observe both intense and weak lines. A total of 2460 lines were measured in the entire region. The $\nu_3$ band at 3018 cm$^{-1}$ was measured at very slow scanning rates and the lines of the P and R branches were resolved into several components. The observed spectrum is shown in five figures.

### Moisture

**New Humidity Standard.** G. O. Handegord and C. E. Till. *ASHRAE J. 2,* 44 (1960) June (6 pp.)

Definitions of the thermodynamic properties of moist air given in the final report of the International Joint Committee on Psychrometric Data leave little scope for the establishment of a fundamental standard of humid-

ity other than the production of a standard atmosphere. The condition of the air-vapor mass in the recirculation system of the atmosphere producer described in this paper necessarily satisfies the definition of an atmosphere saturated at the measured temperature and total pressure within small tolerance. This tolerance arises from the practical limitations in temperature control and the practical limitations on the establishment of the neutral equilibrium condition.

### Sulfur Oxides

**Oxides of Sulfur in the Flue Gases of a Coke-Fired Domestic Boiler.** D. Marsden and R. A. Mott. *J. Inst. Fuel 33*, 267 (1960) June (4 pp.)

The Corbett-Flint method for the determination of sulfur trioxide in flue gases, as modified by Mott and Parramore, was applied to a study of the effects of various factors on the concentration in the flue gases of a coke-fired domestic boiler. The sulfur content of the coke had no effect. Increase in the rate of combustion caused a slight increase. The range of concentration was 7.4 ± 1.8 ppm, which is much less than that in the flue gases of power station boilers. Most of the sulfur of the coke was released as sulfur dioxide, the concentration of which was roughly proportional to the sulfur content of the coke. Ammonia was present in the flue gases in concentrations of about 30 ± 5 ppm.

### X-Ray Techniques

**Electronic Image Intensification of X-Ray Diffraction Patterns.** R. E. Thun, J. Johnson, B. H. Krause and E. A. Meredith. *Anal. Chem. 32*, 939 (1960) July (3 pp.)

Intensification of x-ray diffraction patterns is obtained by using an electronic image converter tube. Diffracted intensity is increased by a $10^2$ factor, thus providing a short exposure time in crystal structure studies by x-ray powder technique.

## 13. BASIC SCIENCE

### Absorption

**Concurrent Gas Absorption Mass Transfer.** W. S. Dodds, L. F. Stutzman, B. J. Sollami and R. J. McCarter. *A.I.Ch.E. J. 6*, 197 (1960) June (5 pp.)

Carbon dioxide absorption in caustic solution was studied. Concurrent flow in gas absorption may be used to practical advantage when liquid partial pressure is minor. The higher transfer coefficients of this operation are reported and analyzed in reference to pertinent variables. The data will be useful for design purposes. Reference ground is provided for a general correlation.

### Catalysts

**The Role of Supports in Catalytic Hydrogenation. Part 1. Specific Effects of Various Oxide Carriers on the Activity of Platinum.** E. B. Maxted and S. Akhtar. *J. Chem. Soc.* 1995 (1960) May (5 pp.)

Zirconia and thoria were found to act as highly active promoters when used as supports for platinum in the liquid-phase hydrogenation of cyclohexene at room temperature. The activity of the complex catalyst containing a fixed amount of platinum first rises to a peak value and then falls with increasing amount of the support, the peak activity corresponding, with zirconia, to about 16 times that of the unsupported platinum and, with thoria, to about 12 times this value. A similar study was also carried out with less active supports, including chromium sesquioxide, ceria, thorium chromite, and magnesia. Electron microscopic studies were also made of the disposition of the platinum on the support.

### Compressibility

**The Compressibility of Carbon Dioxide-Argon Mixtures.** W. H. Abraham and C. O. Bennett. *A.I.Ch.E. J. 6*, 257 (1960) June (5 pp.)

The compressibility factor has been measured at 50°C and 50 to 1,000 atm. for each of seven mixtures of carbon dioxide and argon containing 12.9 to 83.1 mole % carbon dioxide. The compressibility factors are reported as smoothed values at even pressures and also in the form of empirical smoothing expressions which fit the experimental values with an average absolute deviation of 0.1%. Various methods of predicting gas-mixture compressibility are tested, and activity coefficients calculated from the experimental data are reported.

**Modified Law of Corresponding States for Gases.** O. T. Bloomer and R. E. Peck. *A.I.Ch.E. J. 6*, 240 (1960) June (6 pp.)

A new correlation is presented for predicting the pressure-volume-temperature relations of nonpolar (and slightly polar gases). The correlation modifies the law of corresponding states in which a third parameter, the slope of the pseudocritical isometric in dimensionless form, is introduced. A detailed comparison of the method with data on twelve pure gases showed that by introducing this parameter into the law of corresponding states the average error was decreased from 1.598 to 0.320%. A new set of generalized compressibility factor and fugacity to pressure ratio charts is presented for use with the proposed correlation. A method is also presented for determining the thermodynamic functions.

### Diffusion

**Diffusion in Compressed Binary Gaseous Systems.** V. J. Berry, Jr., and R. C. Koeller. *A.I.Ch.E. J. 6*, 274 (1960) June (7 pp.)

Apparatus is described for experimentally determining diffusion coefficients in dense-gas systems to pressures of 15,000 lb./sq. in. abs. Tests were made with the hydrogen-nitrogen and methane-ethane systems at 104°, 139°, and 171° F. to 10,000 lb./sq. in. abs. In all cases it was found that diffusion coefficient predicted on the basis of the Lennard-Jones model with Thorne's dense-gas correction diverged below the experimental data in the high-density region. Coefficients predicted from the Slattery-Bird reduced-state correlation showed better agreement

with the experimental data. The temperature dependence of the results is better described by the exponential form for liquids than by the form of the dense-gas theory.

**Permeability and Diffusivity of Hydrogen Through a Palladium Tube.** O. M. Katz and E. A. Gulbransen. *Rev. Sci. Instruments 31,* 615 (1960) June (3 pp.)

A palladium diffusion tube which supplies high purity hydrogen was constructed for use in a high vacuum glass system. Temperatures of 213° to 379° C and back pressures from 1 to 2 atm $H_2$ were used. In this range the permeability was proportional to the square root of pressure and an exponential function of reciprocal temperature. The tube had a long life if it was kept above 150°C while exposed to the gas. Diffusion coefficients obtained from the permeability experiments were in very good agreement with previous results.

## Distillation

**Plate Efficiencies in Multicomponent Distillation.** H. L. Toor and J. K. Burchard. *A.I.Ch.E. J. 6,* 202 (1960) June (5 pp.)

A first approximation to the multicomponent plate-efficiency problem has been carried out with a film model combined with equations for steady state diffusion in a ternary gas mixture. Numerical integration of the equations through a plate yields the ternary efficiencies as functions of the binary efficiency. The effects of diffusional interactions in a distillation column were studied by computing the efficiencies on each plate when a column is designed to separate a ternary mixture. In the example studied, the average column efficiency was 39% less than the binary efficiency. Some criteria are suggested for comparing other multicomponent systems to the one studied in order to estimate the uncertainty in the use of binary correlations for these systems.

## Fluid Flow

**The Dall Flow Tube.** R. B. Dowdell. *Instruments and Control Systems 33,* 1006 (1960) June (4 pp.)

The Dall flow tube combines the high differential of an orifice wtih the low loss of a venturi. The result is the best recovery factor expressed in per cent of differential. Also included is a presentation of accuracy measurement based on statistical techniques.

**Effect of Natural Convection on Transition to Turbulence in Vertical Pipes.** G. F. Scheele, E. M. Rosen and T. J. Hanratty. *Can. J. Chem. Eng. 38,* 67 (1960) June (7 pp.)

Effect of natural convection on transition to a disturbed flow in a heat transfer section of a vertical pipe was investigated. The transition is related to the distortions of the velocity profile caused by natural convection. When natural convection is in the direction of forced flow the transition appears to occur through the growth of small disturbances. Transition occurs suddenly when natural convection is opposite the direction of forced flow and it appears to be associated with a separation of the flow at the wall.

**Flow Processes at the Inlet Pipes at High Velocities.** A. Naumann and J. Prause. *Jahrbuch Wissenschaft. Gesellsch. Luftfahrt,* 70 (1958) (9 pp. German text.); (From *Appl. Mech. Rev. 13,* 423 (1960) June)

In the first part of the paper the properties of the flow are considered for one-dimensional flow. In the second part the flow pattern is described with references to Schlieren photographs; the authors try to give a more detailed explanation of the condition of flow in the region of contraction. At the convex surface of discontinuity the local field of supersonic flow is considered, which, due to the reciprocating effect of modulation and rolling-up of vortices along the surface of discontinuity, causes formation of shocks. In the region of critical Mach number a rapid increase of contraction ratio is observed, followed by an increase of the mass flow until a normal shock is finally formed at the downstream end of the fluid Laval nozzle. Finally, the property of a very short tube is discussed briefly.

**Multiphase-Flow Problems.** H. C. Bozeman. *Oil Gas J. 58,* 133 (1960) June 27 (2 pp.)

Flow patterns in multiphase flow are classified in seven ways. Pressure drops can be two to ten times greater than for single-phase flow. To reduce error and insure design capacity a strong research effort is required. Therefore in 1958 AGA and API formed the joint multiphase flow committee composed of members experienced in this field. The committee's program is to collect all the test data published and to solicit test data and design methods from companies operating multiphase pipelines.

**Point Source Turbulent Diffusion in a Pipe.** D. L. Flint, H. Kada, and T. J. Hanratty. *A.I.Ch.E. J. 6,* 325 (1960) June (7 pp.)

Turbulent diffusion from a small source located in the center of a 3-in. pipe was studied. Hydrogen and carbon dioxide were mixed in air, and potassium chloride solution was mixed in water. Eddy diffusion coefficients calculated from the data are correlated by plotting $(E)-(2aU_c)$ vs. $N_{re}$. Differences from other data in the literature are discussed. The results could not be used for determining the form of the correlation coefficient because of inaccuracies in the measurements for small diffusion times.

**The Response of a Pressure-Sensing System.** R. P. Benedict. *J. Basic Eng. 82,* 482 (1960) June (7 pp.)

A first order, first degree, linear expression is developed to describe the transient behavior of a practical pressure sensing system. The development is in terms of usual fluid flow parameters. An experiment is described whereby the transient behavior is determined for a variety of pressure sensing systems. Experimental uncertainties are determined. Comparisons are drawn between several published expressions, the proposed linear expression, and the experimental data reported herein, to indicate the validity of the proposed expression.

**The Stability of Shockfree Transonic Gas Flows.** M. Schafer. *Jahrbuch Wissenschaft. Gesellsch. Luftfahrt,* 64 (1958) (5 pp. German text.); (From *Appl. Mech. Rev. 13,* 423 (1960) June)

The problem for discussion is whether in a plane potential flow with supersonic velocity a continuous transition to subsonic velocities is possible or whether the transition is only possible by means of a shock wave, i.e. discontinuous. Whereas till now experiments have only shown dicontinuous transition, mathematically a class of solutions of the basic gas dynamic equations is known which corresponds to a unilaterally bounded flow, where a supersonic region is contained without a shock in a subsonic flow. The shape of the boundary, however, is completely defined. With reference to two basic special cases the stability of such a flow is investigated with regard to its return from supersonic to subsonic velocities without the occurrence of a shock if the boundaries in the supersonic region are modified locally.

**Symposium on Boundary Layer Research.** H. Gortler. International Union of Theoretical and Applied Mechanics, Freiburg, Germany, Aug. 1957; (Berlin, Springer-Verlag, 1958) 411 pp. $14.00; (From *Appl. Mech. Rev. 13,* 426 (1960) June)

This book is a contribution to the understanding of theory and research problems on boundary layer problems.

**The Thermal Entrance Region in Fully Developed Turbulent Flow.** P. H. Abbrecht and S. W. Churchill. *A.I.Ch.E. J. 6,* 268 (1960) June (6 pp.)

The temperature profile and the local rate of heat transfer from the wall were measured at 0.453, 1.13, 4.12, and 9.97 tube diameters downstream from a step increase in wall temperature for air in fully developed turbulent flow at Reynolds numbers of 15,000 and 65,000 in a 1.52 in. tube. The velocity profile and the pressure were also measured at these lengths. Radial and longitudinal temperature gradients, radial heat fluxes, and eddy diffusivities for heat and momentum transfer were computed from the measurements. The longitudinal temperature gradients at all radii were found to differ significantly from the mixed mean temperature gradient. Although the radial heat flux was a maximum at the wall, the radial heat-flux density, in terms of which the eddy diffusivity for heat transfer is usually defined, was found to go through a maximum near the wall and then to decrease almost linearly across the thermal boundary layer. The eddy diffusivity for heat transfer was found to be independent of length in the thermal entrance region and hence a function only of the fluid motion, as previously hypothesized.

**Use of Momentum Balance in Calibrating Orifices for Flow of Gases.** J. J. Martin and V. R. Pabbi. *A.I.Ch.E. J. 6,* 318 (1960) June (4 pp.)

A method of determining the absolute calibration of a gas-flow orifice without the use of gas holders or any comparative device is described. The method is based on the application of the momentum balance, as well as the energy balance, to the flow of the gas. The application requires the measurement of pressures on the face of the orifice in addition to the usual pressure-drop measurements along the axis of flow. Orifice coefficients determined by the force-momentum principle are shown to agree within an average deviation of 1.4% with those determined by other standard techniques. Also the application of the force-momentum principle demonstrates clearly why orifice coefficients are much less than unity.

## Fluidization

**Elutriation of Solid Particles from a Dense-Phase Fluidized Bed.** C.-Y. Wen and R. F. Hashinger. *A.I.Ch.E. J. 6,* 220 (1960) June (7 pp.)

The elutriation of fines from fluidized beds of two- and multiparticle systems is investigated. Materials used are glass beads and coal powder with air and helium as the elutriating gases. A specific elutriation rate constant which takes into consideration the particle stratification and thus is nearly independent of the bed dimensions is employed in the correlation of the elutriation of fines. The proposed generalized correlation applicable to a system of two particle sizes and to more complex ones is presented. Recorrelation of pertinent literature data by the dimensionless equation indicates good agreement in spite of a diversity of bed geometries. The effect of fluidized-bed parameters on the rate of elutriation is examined, and applications and limitations of the correlation are shown.

## Heat Transfer

**Researches on New Heat Transmitting Tubes.** K. Nakamura, S. Fukunaga, T. Sawada, M. Matusita and N. Kamo. *Bull. Japan Soc. Mech. Eng. 2,* 376 (1959) Aug. (6 pp.); (From *Appl. Mech. Rev. 13,* 437 (1960) June)

Paper is a summary of a series of investigations into forced convection heat transfer from air to circular tubes. Tubes have either one or two axial fins fixed to outer surface. The relative angular position of the fins is one of the variables in experiments on two-fin tubes. For flow normal to one of these tubes, a 50% increase in overall heat transfer occurs when fins, 10 mm deep, are inclined at 40 deg to each other, are on the upstream side of tube, and are symmetrical about direction of air flow. Air velocity is varied from 3 to 9 m/sec. Such tubes, arranged in staggered banks of four rows, also show increased heat transfer and decreased pressure loss over plain tubes, similarly spaced.

## High Temperatures

**Physical Background of High Frequency Heating.** C. Zwikker. *Ingenieur 70,* 43 (1958) Oct. (4 pp. German text); (From *Appl. Mech. Rev. 13,* 437 (1960) June)

Formulas are derived for the heat evaluation for inductive and capacitive heating. Inductive heating is computed for a rod surrounded by a cylindrical coil and capacitive heating is computed for a similar rod with circular electrodes placed at the ends of the rod perpendicular to the axis of the cylinder. In this way similar equations are obtained for both methods of heating.

The theory is given assuming that the permeability, the dielectric constant, the conductivity and the density of the heated material are constant. A brief discussion is given of the influence of the temperature dependence of these constants.

## Kinetics

**The Effect of Moderators on the Reactions of Hot Hydrogen Atoms with Methane.** P. J. Estrup and R. Wolfgang. *J. Am. Chem. Soc. 32,* 2661 (1960) June 5 (5 pp.)

Reaction of recoil tritium with methane was examined in further detail. The previous hypothesis that this system involves a hot displacement reaction of high kinetic energy hydrogen to give $CH_3T$, $CH_2T$ and HT is confirmed. The effect of moderator on this process is studied by the addition of noble gases. As predicted these gases inhibit the hot reaction, their efficiency in this respect being He>Ne>A>Xe. The data are quantitatively in accord with a theory of hot atom kinetics. The mechanism of the hot displacement process is briefly discussed.

**Kinetic Theory of Hot Atom Reactions: Application to the System H+$CH_4$.** P. J. Estrup and R. Wolfgang. *J. Am. Chem. Soc. 82,* 2665 (1960) June 5 (5 pp.)

A model was developed for the kinetics of hot atom reactions in the gas phase. An expression is derived giving the total probability that a hot atom will react before losing its excess energy, in terms of the average collisional energy loss and the efficiency of reaction upon collision. The model predicts the relative effect of inert moderating compounds and provides a measure of the relative energy at which various products are formed in reactions with a given substance. The theory is tested using experimental data on the action of moderators on the reactions of hot hydrogen with methane and is found to provide a good representation of this system.

**Transport in Dilute Gases and Chemical Forces.** R. K. Osborn. *J. Chem. Phys. 32,* 1817 (1960) June (3 pp.)

It is shown that the theory of transport phenomena in gases may be so formulated that the potentials characterizing the cross sections, which account for interactions between molecules in the binary collision limit, are the same as those conventionally employed in investigations of molecular structure. Thus it is indicated that at least some of the essential features of chemical forces may be conveniently introduced into the description of such phenomena.

## Mass Transfer

**Simultaneous Mass Transfer and Equilibrium Chemical Reaction.** D. R. Olander, *A.I.Ch.E. J. 6,* 233 (1960) June (7 pp.)

Equations predicting the effect of various types of equilibrium chemical reactions on the liquid-phase mass transfer coefficient have been derived. In each case the reacting species were assumed to be present in equilibrium concentrations at all points along the diffusion path. Equations were derived for both the film and surface-renewal theories of simple mass transfer in conjunction with these equilibrium reactions. The well-known Hatta equation for the rapid second-order irreversible reaction was shown to be a limiting case of the general equilibrium reaction $A + B \rightleftarrows E$. The calculated mass transfer coefficients were found to be functions of the concentration driving force and the average concentration level over the diffusion path as well as of the magnitude of the equilibrium constant and the diffusivities of the reacting species.

## Methane

**The Inhibition of the Hydrogen + Oxygen Reaction by Methane.** R. R. Baldwin, N. S. Corney and R. W. Walker. *Trans. Faraday Soc. 56,* 802 (1960) June (13 pp.)

Characteristics of the inhibition of the $H_2 + O_2$ reaction by methane are shown to differ markedly from those found with ethane and the higher hydrocarbons. Four types of mechanism were examined: 1) a mechanism retaining the isothermal nature of the limit and assuming a direct inhibition by methane, 2) a thermal explosion, with direct inhibition by methane, 3) an isothermal limit, with inhibition due to formaldehyde which has reached an equilibrium concentration, 4) inhibition due to formaldehyde which has not reached a stationary concentration when the critical condition for explosion is reached.

## Phase Equilibria

**Applied Hydrocarbon Thermodynamics. Part 18. Vapor-Liquid Equilibrium Fundamentals.** W. C. Edmister. *Petrol Refiner 39,* 181 (1960) June (12 pp.)

The equilibrium phase distribution ratio, better known as K values for components of a mixture can be found experimentally by finding the composition of the vapor and liquid from an apparatus designed and operated to achieve an equilibrium separation of the equilibrium vapor and liquid phases. Experimental measurements, however, are time consuming and costly so theoretical and empirical methods are also used to predict and correlate K values, thus making experimental observations go further. These theoretical and empirical methods are utilized by thermodynamics, as the author demonstrates after showing the relationships between K values and fugacity, pressure and vapor pressure.

**Hydrocarbon Vapor-Liquid Equilibria and Solubility Parameter.** J. M. Prausnitz, W. C. Edmister and K. C. Chao. *A.I.Ch.E. J.6,* 214 (1960) June (6 pp.)

Hydrocarbon vapor-liquid equilibria are expressed in terms of K values, which are functions of composition, as well as pressure and temperatu e. The composition effect in the liquid phase is calculated by the Hildebrand-Scatchard equation for regular solutions. The parameters in this equation, called solubility parameters, can be calculated simply from heat of vaporation for the heavier hydrocarbons, but an indirect method of calculation must be used for the lighter components. Solubility parameters for hydrogen, methane, ethane, and propane were computed from gas-solubility data in several

hydrocarbon solvents at various temperatures and pressures. This computation also yielded simultaneously the fugacities of the hypothetical liquid-standard states. The results presented are not complete for practical applications, owing to the scarcity of suitable solubility data, especially at high temperatures and pressures. However solubility parameters appear to give the right liquid-phase corrections in the correlation and prediction of hydrocarbon phase equilibria. Calculated K values for light hydrocarbons in paraffinic, napthenic, and aromatic absorption oils are compared with experimental results. The average deviation for the forty-two values tested is 13%.

## Ultrasonics

**Mechanisms by Which Ultrasonic Energy Affects Transfer Rates in Liquid-Liquid Extraction.** H. A. Woodle, Jr., and F. C. Vilbrandt, *A.I.Ch.E. J.6,* 296 (1960) June (3 pp.)

Concurrent and spray-tower studies have been accomplished that illustrate the effect of ultrasonic insonation on transfer rates in liquid-liquid extraction. Stage efficiencies and over-all transfer rates in the system toluene-methyl alcohol-water were determined with and without insonation of the system at frequencies of 40 and 800 kc. Insonation was shown to have a positive effect on mass transfer in both concurrent and spray-tower operations. Insonation of the system provides for increased interfacial area between the two phases, removal of relatively stagnant liquid layers at the interface, and increased circulation currents within a single liquid phase. Low-frequency insonation favors local agitation and mixing of the phases, and high-frequency insonation favors induced circulation currents.

## Viscosity

**Method of Calculation of the Transport Coefficients of Air at High Temperatures.** E. V. Stupochenko, B. V. Dotsenko, I. P. Stakhanov and E. V. Samuilov. *ARS J. 30,* 394 (1960) April (9 pp.)

This paper contains theoretical calculations of the transport coefficients of air—the viscosity and heat conduction—in the temperature range from 2000° to 8000°K and in the pressure range from 0.001 to 1000 atm. As in the case of the thermodynamic quantities, there are still no well developed experimental methods available for the direct study of the transport properties of gases at such high temperatures. The first section of this paper is devoted to the principles of calculating the viscosity of air under the conditions indicated. In the second section the authors analyze transport phenomena in a mixture of reacting gases.

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